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Engineering News-Record

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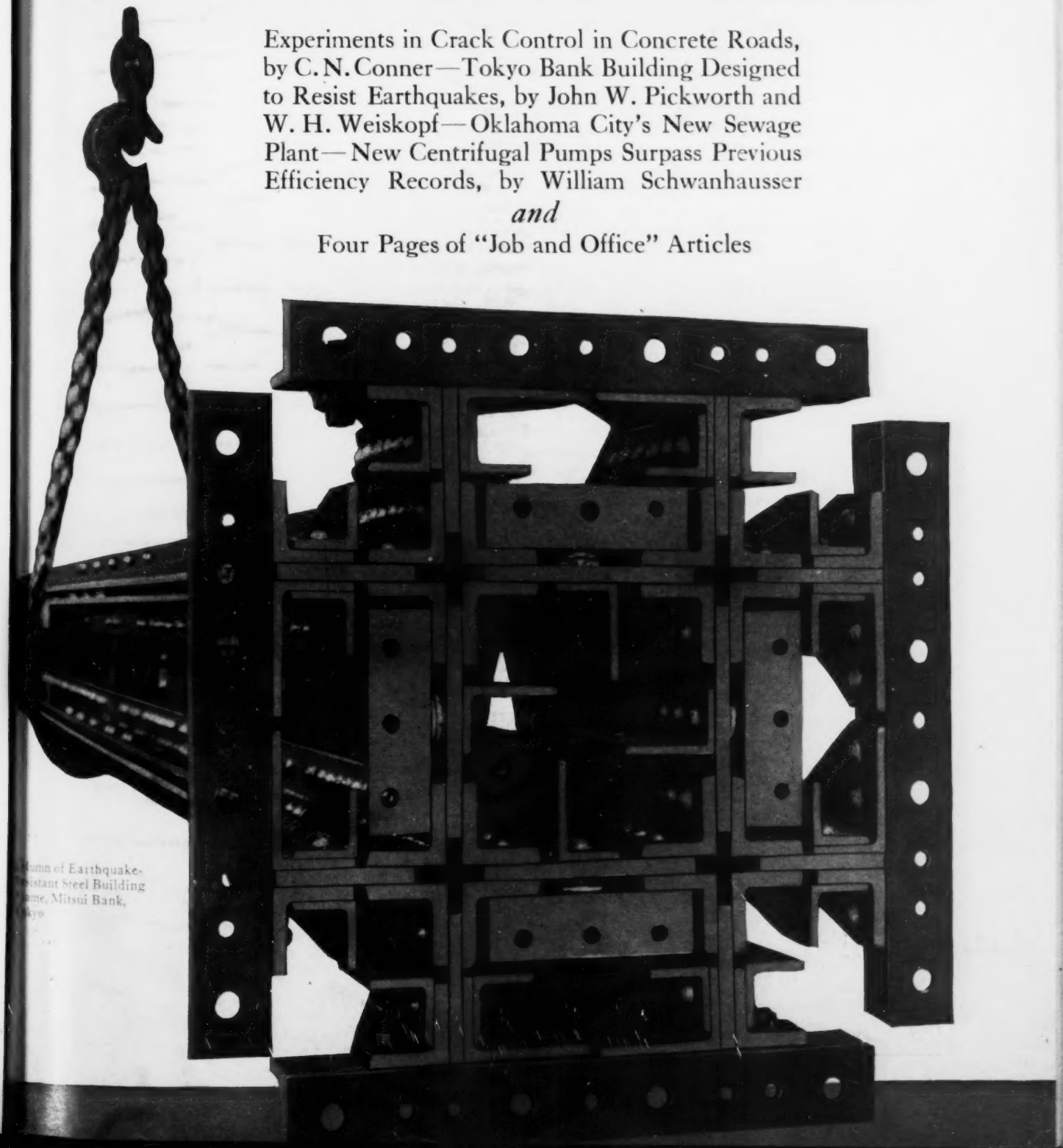

Column of Earthquake-Resistant Steel Building Frame, Mitsui Bank, Tokyo

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FRANK C. WIGHT
Editor

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The Detroit Pumps

UNUSUAL methods to meet unusual conditions were followed with remarkably good end results in the design of two large centrifugal pumps for the Detroit water-works. What these were as well as the world record-breaking test results for one of the pumps is detailed elsewhere in this issue. The Detroit pumps illustrate the flexibility of motor-driven centrifugal pumps as well as the speed with which they can be designed and built.

Small Water Power Plants

IN CONSIDERING the development of water power on our streams the large and attractive sites usually are the ones which receive the most attention, little thought being given to the smaller sites or to the amount of money that can be expended upon them economically. The fallacy of this procedure is emphasized in an article on the small hydro-electric plants of Nebraska, published elsewhere in this issue. The topography of that state is such that few large water power plants can be built, but there are many places where small plants ranging in capacity from less than fifty to two or three thousand horsepower can be built. Most of these sites have been developed, frequently as grist mills which were later converted into electric plants, at costs ranging from $150 to $666 per kva. Individually, these plants are insignificant, but collectively they supply a considerable portion of the power requirements outside of the larger cities, and at rates comparable with those in the larger communities supplied with power from modern steam plants.

New Views of Strength

IN OLDER days the constructor appraised his materials largely in terms of their static resistances. Forces applied in this way or that, in a tensile or bending test, were the criteria for choice of material and for assignment of working stress. This habit of thought has been undergoing an extensive readjustment of late, in the light of developing facts about fatigue and endurance. A host of research workers has been active in this field for a decade or two, attempting to answer the new questions presented by the more intensive demands of modern construction—especially those growing out of two dominating machines of the present era, the steam turbine and the airplane. New results of their investigations are brought forward constantly; within the past month alone a number of papers and books on endurance have come off the press. We are approaching the point, it appears, where views of material strength will center on the facts of endurance testing almost as basically as they once did on static-strength data. It is not inconceivable that in time we may write down fatigue endurance as the basic strength figure of any material, considering other resistances as only modifications of this datum quantity. That time is still some distance away, but each advance in knowledge of endurance and each approach to a better understanding of how and why a piece fails under fatigue test brings us more out of relation to the old concepts of static strength and the wide safety margins based upon them. These changes of view have meaning not alone to the machine-builder but also to the structural engineer: the builder of bridges and tunnels and dams. He too is concerned with constant variation of stress; the static conditions on which his designing methods were premised under the classical theories are little more than fictions. His future thinking, therefore, is going to be dependent on endurance facts. Already there have been indications that structural engineering estimation of strength and load is coming to be referred to endurance facts. There is likely to be steadily continued progress in that direction.

Jersey's Zoning Campaign

CONTINUED refusal of the highest courts of New Jersey to sanction zoning increases the importance of getting support for the zoning amendment to the state constitution which has passed two legislatures and goes to a referendum vote on Sept. 20. The New Jersey courts held, some two years ago, that certain zoning ordinances violated the constitutions of both the State of New Jersey and the United States. The decisions, since rendered, of the United States Supreme Court that zoning ordinances of Euclid, Ohio, and of cities in two or three other states do not violate the federal Constitution leave the New Jersey courts only one leg to stand on. Even if it is a wooden leg, it is sufficient for the purpose. There remains nothing to do but to amend the New Jersey constitution. That will have its advantages in any case, as it would in any other state where doubt remains as to the legality of zoning. The popularity of zoning in New Jersey is attested by the large number of cities that have been zoned and by the strenuous efforts of many of them to maintain their ordinances, despite repeated defeats in the courts. Among the other signs favorable to adoption of the amendment are appeals by mayors to their citizens to support zoning. The mayor of Jersey City has put the case strongly in an appeal that will doubtless be circulated widely and have much weight, since he is state leader of one of the two political parties. Moreover, since the zoning amendment was put through the legislature by the opposing party, support from that side may also be expected. The mayor of Montclair, a prominent engineer, has appealed to the voters of that town to support zoning. The New Jersey State Chamber of Commerce has created a pre-zoning committee headed by Walter Kidde, until recently engineer-member of the New Jersey

Highway Commission. It would be foolish for the friends of zoning to assume that victory awaits them. There will be vigorous opposition from piratic builders, who do not mind ruining a residence street for their own profit, and from short-sighted realtors. Moreover, the New Jersey Building & Loan Association, presumably a federation of local associations, at a recent convention adopted a resolution against the zoning amendment, evidently without realizing that the class of people who build homes through such associations will be the greatest losers if the amendment is defeated. The whole country will watch with interest the New Jersey zoning campaign and its outcome.

Division of Labor

WATER and sewage treatment have seen many changes since their beginnings. Notable among these changes have been the increase in the division of labor. When mechanical filtration of water was brought to the front, forty years ago, one of the claims for it was that it obviated the necessity for sedimentation. In the ruinous rivalry between the many early companies one went so far as to claim that pre-coagulation was unnecessary, even for the turbid Mississippi at New Orleans. Result, a plant on its hands for non-fulfillment of contract, and financial complications that hastened the consolidation of the various companies then promoting and building mechanical filters. Since those long-ago years, mixing chambers and pre-coagulation basins have become the rule. Double or split coagulation has been adopted at various places and experimented with at Cincinnati, as noted elsewhere in this issue. Added to the coagulation and filtration, we now have pre- and post-chlorination and numerous other examples of division of labor will occur to anyone familiar with water and sewage treatment. In various ways, greater efficiency or economy, or both, are obtained by splitting up the work, either as in pre- and post-coagulation or chlorination, or by using two or more quite different agencies. There is no reason to think that the end has been reached. Both water and sewage vary so in character, here and there, and from time to time in the same place, that there are and will be many variations for the sanitary engineer, chemist and biologist to adopt for general or temporary use. Demands upon technical men do not stop with division of labor. They include intensification of treatment, as with excess lime and superchlorination; and rectifying agencies, as dechlorination (rarely in North America as yet), and decarbonization of softened waters, the latter also discussed elsewhere in this issue.

Engine Terminal Economics

DESIGN, location and operation of engine terminals as related to the economics of railway operation was emphasized by L. K. Sillcox, general superintendent of motive power of the Chicago, Milwaukee & St. Paul Ry., in his presidential address at the recent meeting of the mechanical section of the American Railway Association. He pointed out that although the tendency toward material increase in the length of engine runs should reduce the frequency of enginehouse or terminal service in relation to the mileage run, yet as a matter of fact the enginehouse expense has not decreased as much as it should have done. From the high point of 10.03c. in 1920 for enginehouse expense per locomotive transportation service mile, this expense dropped gradually and continuously to 6.9c. for 1925. Mr. Sillcox estimated that this expense will be about 6c. per mile until an increase in the number of new or reconstructed terminals providing greater efficiency in service permits a further reduction in cost. Improvement in engine-terminal service may be considered in two ways: (1) As to the spacing between engine terminals, or the number of terminals required for given traffic conditions; (2) as to the arrangement and mechanical equipment of terminals. At present the average spacing on different railroads ranges from 60 to 100 miles, which affects the enginehouse expense per mile run. Track layout and location of the several facilities at individual terminals has an important effect upon terminal expense, especially as to the labor cost, which constitutes a considerable proportion of the expense. A marked improvement in fuel performance has been effected in recent years by the installation of hot-water plants for washing out and refilling the boilers at enginehouses, not only reducing the cost of engine fuel for starting fires, but also reducing the time required for this work, and consequently the time when the engine is out of service. In general, the improvement of engine terminals has been considered mainly on the basis of economy and convenience of individual terminals, rather than as an item in the operating economy of the railway as a whole. It is the importance of this second feature which Mr. Sillcox stressed.

Earthquake Resistant Construction

WITHIN a very few years, the matter of protecting against earthquake effects has become decidedly prominent. Not only engineers but also building owners, financial authorities and insurance men have given the subject such attention as the limited available knowledge permits, and this concern in the subject is increasing rapidly. There is no longer much chance for doubt as to the possible effect of severe earthquake disturbance in various parts of the world, since the repeated large-scale demonstrations in Japan and those in San Francisco and Santa Barbara. It is relatively easy to reach fairly definite conclusions as to the destructive effects on modern life and the necessary construction in the case of such disturbance. Little comfort can be obtained from the accumulated experience of the past, for the few decades since modern buildings, pipe-line systems, power plants and the like came into existence are short compared to the long chapters of seismic history. The concern which the problem has aroused is therefore quite natural.

One thing reasonably certain is that present building practice is far from strong enough to give much security in a strong earthquake. With this conviction, however, many have come to believe that earthquake resistant building is quite impossible. The lack of precedent in earthquake resistant construction, and the widespread—it might almost be called universal—extent of destruction in violent earthquakes lends some support to such pessimism. But probably a truer statement of the present fact would be to say that earthquake resistant construction still remains to be developed.

In California, a decidedly unfavorable attitude has recently been taken by underwriting interests toward

earthquake insurance, based on careful study of the elements of resistance of existing buildings in comparison with possible earthquake forces. This in itself does not argue that the study led to the conclusion that protection against earthquakes is impossible, but it does indicate the magnitude of the problem and the wide extent of the interests affected. The insurance aspect is important because of the pervasive relation of insurance, or equalization of individual risk, in the structure of modern life.

In Japan, the problem of building for safety against earthquakes is being attacked with determination. Measurements of earthquake motions and estimates of the forces involved lead to the conclusion that it is possible to obtain, if not complete security, at least a high degree of protection against even very violent earthquakes. The most interesting example of the results of this determination is described this week by the designers. It is the frame for a large, heavy, ornamental bank structure now under erection in Tokyo. It represents, on the basis both of the Japanese estimates of requirements and the American engineers' study of structural possibilities, an adequate solution of the problem of protecting this very important building.

In order to meet the needs of the case it was necessary to go well outside the range of current practice in steel frame construction. An ingenious new form of column was developed, very heavy and rigidly connected girder systems were designed, and due recognition was given to the controlling influence of distortion bending in these members by making them heaviest near the joints and lightest toward the center. The results justly invite detail study.

On the score of cost, not much is known as yet in this new field. The Mitsui building, however, would appear to involve no staggering excess cost for its earthquake protection. It is understood that the total steel requirement is something more than twice that of a building designed under ordinary American standards; and if we take the cost of the framework of an ordinary building as 10 per cent of the total cost, it would mean that the cost of this building has been increased 10 or 15 per cent by the earthquake provisions. Perhaps the addition will be somewhat larger if corresponding precautions in the masonry and other elements of the structure are taken into account, but, at any rate, the total is by no means forbiddingly large. It gives definite encouragement for the belief that earthquake resistant construction is not only wholly practicable but that it involves no prohibitive expense.

Needless to say, Japanese earthquake possibilities need not be taken into account in designing for any American conditions that have yet been recognized. Very much lighter forces may be contemplated even in our least stable regions. Correspondingly, the practicability of earthquake resistant construction is increased and the cost involved is decreased. The present instance, therefore, offers definite encouragement that where security against earthquake destruction must be provided, it can readily be done.

As said at the outset, earthquake construction is a subject of the future. The present is a pioneer attempt, and forms a valuable precedent. Study of flexibilities and of the best way of assuring complete interaction between the framework and skin of a building will doubtless come later, as additional attacks are made on the problem.

An Innovation in Road Schools

THE first department school for highway employees is in operation in New Mexico. Schooling employees is a function of state highway departments which has grown out of necessity. The rapid growth of highway construction and maintenance into a major public works activity found no supply of previously trained roadbuilders to draw upon. They had to be developed within the department. A contributing influence has been the constant turnover of department heads and employees with changing politics and with calls from contractors, materials producers and equipment manufacturers for men trained in highway department work. Replacements had constantly to be provided.

The road school has been a natural growth. Ordinarily this has been of somewhat informal character. Once a year the employes of the department, or certain ranks of these employees, have been called together and addressed on policies, practices and methods. Commonly, the state university has co-operated with the highway department in conducting the school. It has ordinarily lasted only a few days or a week. Occasionally the sessions have been longer and the addresses and lectures have been arranged into something of the nature of a curriculum and these have merged into regular short collegiate courses in highway engineering. Indeed, the road school as conducted has taken on all sorts of variations. In Missouri, two years ago, correspondence school methods were adopted. Always, however, the highway department road school has been of the nature of an informal extraneous activity of the department.

In the new road school in New Mexico this characteristic has been changed. The school is a regularly established department activity. It is located at Encino, almost in the center of the state, has several buildings and shops, and provides a regular course of instruction combining lectures, shop work and field work. There is available for practice at least one unit of every kind of equipment used by the department. The students are selected rather carefully from many applicants; they are paid during instruction enough to live on, and, when the course is completed, they are given regular assignments in the department's maintenance forces. Primarily, the school is intended to train maintenance employees.

Without further explanation, it will be plain we think that the state road administration of New Mexico has broken new ground in carrying out a task that confronts highway departments. Its experiment will be observed with interest. It has done well, also, to direct its schooling to maintenance workers. If any criticism holds true broadly of the road school as it has generally been conducted, it is that its instruction has been directed to men too high up in the ranks and has centered too much on the more abstruse and undetermined problems and practices of highway improvement. There are the engineering schools, the research bureaus and the technical associations—many of each—for schooling the road engineer and the higher technician in other lines. The highway workman and particularly the maintenance workman, is the man for whom the department road school should be conducted and its course of lessons planned. And the lessons must go beyond the telling of how things are done to the teaching of how to do them. It is in accomplishing this duty that the New Mexico school offers high promise.

Tokyo Bank Building Designed to Resist Earthquakes

Mitsui Bank Structure Proportioned for Thrust of One-Tenth Gravity—New Column Type and Double Girder Bracing—Front Columns Stiffened by Auxiliary Bents

By John W. Pickworth and Walter H. Weiskopf
Of Weiskopf & Pickworth, Consulting Engineers,
New York City

WHEN the Mitsui Bank of Tokyo four years ago took up the project of constructing a new bank building, its officers from the first took the view that the building must have the highest practicable degree of resistance to earthquake shocks. The very recent experiences of the great 1923 earthquake, however, had revealed so many deficiencies in even the most substantial buildings previously constructed that they realized the seriousness of the problem presented by their plan. The Tokyo Building Department officials, with the aid of the best seismologists in the country, had established regulations for earthquake-proof building which may fairly be accepted as containing adequate requirements for such construction; but it was not known whether and how these requirements could be met in an actual building structure.

So far as could be learned, no building had yet been designed or constructed which fully met the requirements of the official regulations. The great importance of the proposed bank building, however, made it obvious that thoroughgoing precautions against earthquake damage to the building would be justified; that no effort should be spared to develop a form of construction not only meeting the requirements of the regulations, but also satisfying any still more stringent requirements that might be indicated by careful study of earthquake wave action upon buildings. The officials of the bank placed the problem before Samuel C. Weiskopf, senior member of the writers' firm, who succeeded in devising a form of construction fully satisfying all the requirements, although decidedly radical in character.

This design was, after careful consideration, approved by all concerned, and the detail plans were worked out in accordance with it. The building is now under construction, the first and heaviest part of the steel framework being already erected.

The building, Fig. 1, is to be an imposing and dignified structure. Its length, 350 ft., stretches the full length of a block, so that three of its sides face on streets. The architectural treatment of these sides consists of a row of granite columns extending to the third floor, flanked on the end bays on each side by substantial pylons.

Practically the entire area of the building at the first floor is devoted to a great open banking room, 36 ft. high from floor to ceiling, through which extend slender columns. Above are four floors devoted to offices for the administration of the company.

General Design—Under the latest revision of the Tokyo building law, the lateral force which an earthquake may impose upon a building is to be taken as one-tenth of gravity. No consideration is given to vertical forces, as observations by the Japanese authorities show them to be negligible. This requirement is based on the officials' interpretation of the behavior of large structures in the 1923 earthquake; it represents a horizontal acceleration of about 3 ft. per sec. per sec., which, while exceeded in some areas of very soft ground, was apparently not materially exceeded anywhere on ground presenting substantial foundation. Since a lateral force of one-tenth the weight of the super-incumbent parts of a structure would produce very severe bending actions, flexural strength of all the members obviously was a controlling feature of the design. In view of the stringent architectural requirements, the large tensile forces developed by bending, and the reversal of stress occurring in earthquake vibrations, a structural steel frame was the only suitable type of construction.

FIG. 1—EARTHQUAKE-PROOF BANK BUILDING IN TOKYO
From perspective of Trowbridge & Livingston, Architects.
Building now under construction

Consideration of the distribution of bending stresses in a steel-frame tier building, when these bending stresses are large compared with the vertical loads, suggests that the typical proportioning of the members of the framework for strength should represent a strength distribution somewhat as in the cellular structure sketched in Fig. 3. The members then should be heaviest at the junction of column to girder (since the connection itself is subject to the maximum moment) and becoming more slender toward mid-length. This, in fact, is the manner in which the members of the frame were proportioned. The diagram also suggests another radical departure from ordinary construction, namely the location of column splices at mid-story, the point of contraflexure.

An interesting feature in the consideration of earth-

quake forces in contrast to forces from wind is that the columns are subject to bending stress of the same magnitude in any direction; and this stress is entirely independent of the shape of the building. Thus, while adding a bay to a building will provide additional columns through which to distribute the horizontal shear, yet at the same time it increases the magnitude of this shear in proportion, so that the bending moments are the same as before. It is obvious that the columns, being subject to equal bending in both directions, must have equal strength about both axes and be designed so that proper connections can be made to girders and trusses in both directions.

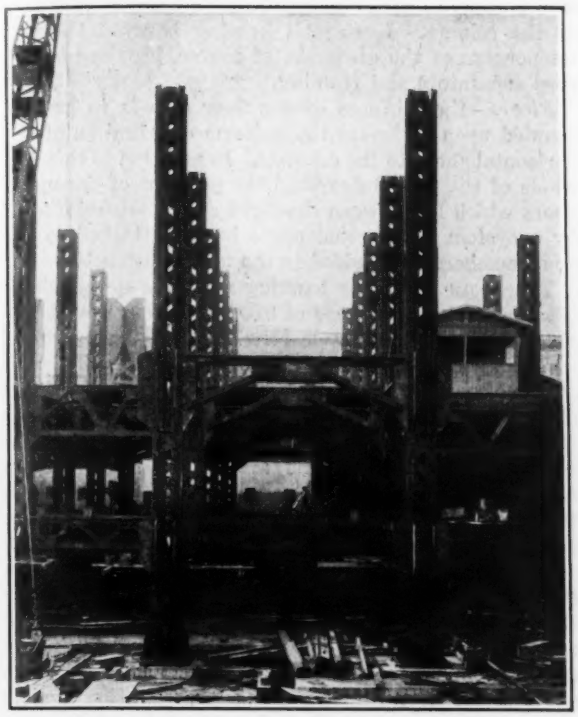


FIG. 2—HEAVY LOWER PART OF FRAME OF MITSUI BANK ERECTED

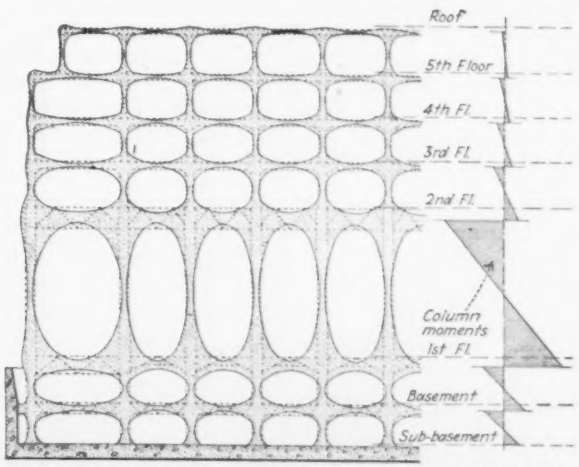
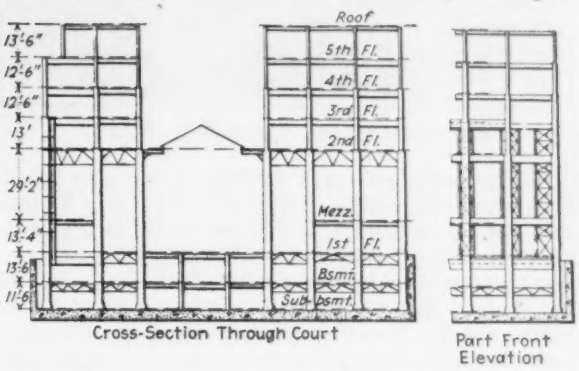


FIG. 3—DIAGRAM ILLUSTRATING STRENGTH PRINCIPLE EMBODIED IN FRAMING OF MITSUI BANK, TOKYO
At right, bending-moment diagram for typical column.

The features just noted—the steel frame, the magni-



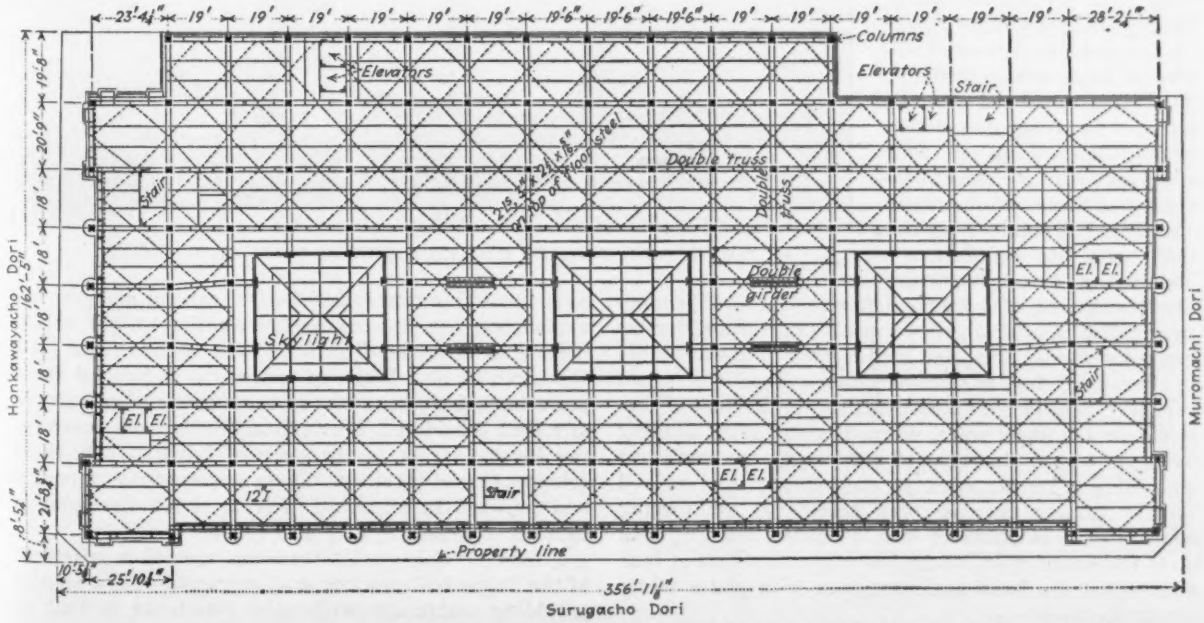


FIG. 4—FRAMING PLAN OF SECOND FLOOR AND CROSS-SECTION OF FRAME, MITSUI MAIN BUILDING

tude of the stresses to be carried, a theoretical proportioning of the members which provides maximum section near the panel points, the location of splices at mid-story height, a design of members that lends itself to strong connections of columns to girders in both directions—these constitute the essential features of the design of the Mitsui Main Building.

FIG. 5—HANDLING COLUMN AT WHARF

Columns—By reference to Fig. 4, showing small-scale plan and sections of the building, it may be seen that the desire to provide a large, unobstructed banking floor in the first story imposed a severe requirement on the design, the great story height causing a correspondingly large bending moment from the earthquake shear. Mainly because of this, it was necessary to use a form of column of large section modulus. The form developed for the purpose is a square section heavily latticed on all four sides, each corner element consisting of three 5x5-in. angles (see Fig. 7, a detail of one column with its connections). This section, symmetrical about both axes, afforded maximum resistance to bending in any direction for a given overall diameter and for the desired sectional area, and at the same time was suited to riveted splicing, to efficient girder connections in two parallel planes in both directions, and to increase of section near the panel point, where the maximum bending moments occur. Increase of section was accomplished by adding a fourth angle to each corner element and (where further increase was necessary) reinforcing angles to the outstanding legs. This section was used up to the second floor; above, the column consists of four angles that are laced and reinforced with plates where required.

Bracing Girders—The large bending moments coming upon the bracing system required floor girders of large depth. In the lower stories these girders are lattice or truss members, while near the top of the building they are plate girders or rolled beams. In all cases the members are double, each consisting of two trusses or girders parallel to each other, one in the plane of each side of the column. Horizontal bracing between the two components of the girder is, of course, provided by the steel separators and framing.

Floors—the stiffness of the floor slab is in general counted upon to insure the uniform distribution of the horizontal shear to the columns. In addition to this, the whole of the second floor and the portions of the upper floors which lie between the light courts are reinforced by a system of diagonal angle braces attached to the floor members and bedded in the floor construction.

The floors above the banking room are designed for office use, with a live-load of 370 kg. per sq.m., which is about equivalent to the old New York code requirement of 75 lb. per sq.ft. The dead-loads are necessarily large, as stone concrete must be used for the 4-in. slab (proper cinders are not available in Japan) and a thick fill is required to accommodate an elaborate system of conduits. The exterior walls are of Japanese granite backed up with reinforced concrete and supported on the structural steel at each floor. All the permanent partition work is of reinforced concrete.

The total loads of the columns do not vary greatly in any one story, and it was found expedient to consider the horizontal shear from shock as equally divided among the columns. This made equal bending in any direction in the columns of each story, and with the small variation in loads an economical selection of sizes was possible from a small number of column designs.

The law prescribes a unit stress of 16,000 lb. per sq.in., and this was followed after careful analysis had established the maximum stresses that might result, depending upon the direction of the applied force from the earth shock. While of course the horizontal shear per column is independent of the number of columns in any bent considered, the vertical forces from overturning became larger in the cases of bents of only three columns braced together. These stresses were computed and included in all cases. Fig. 3 shows the bending moment diagram for a typical column.

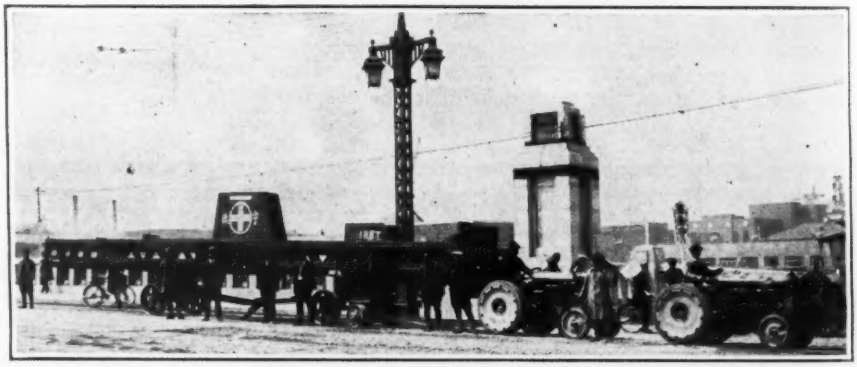
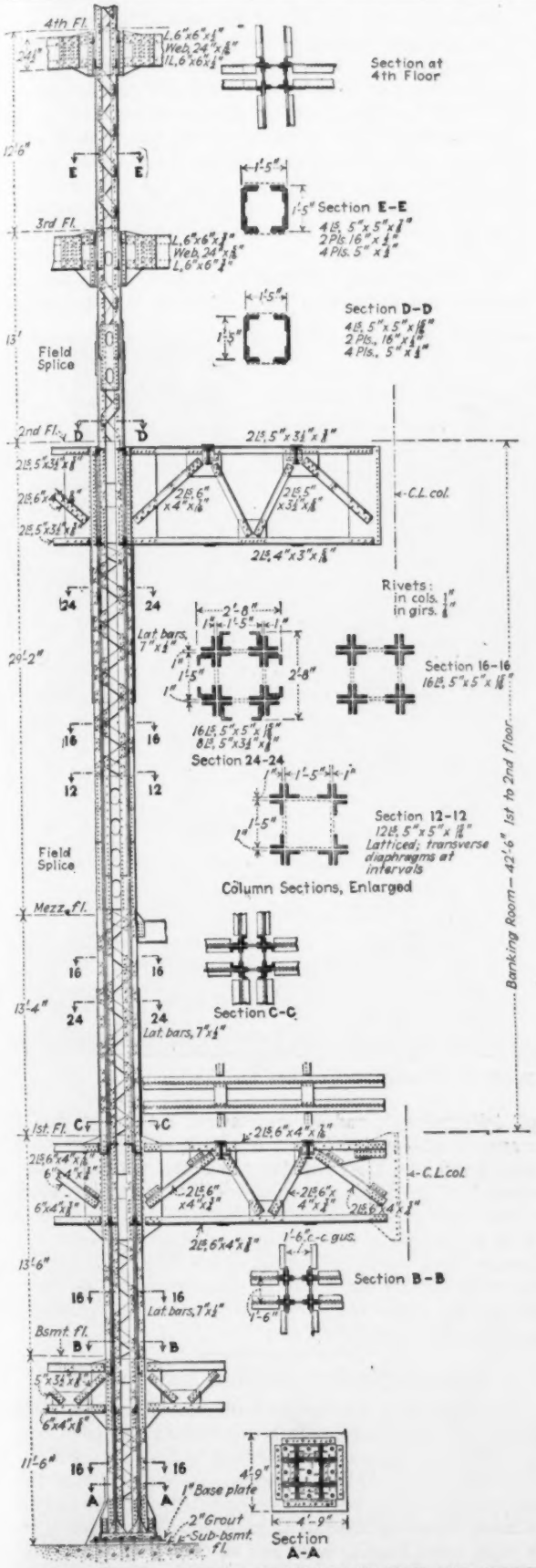


FIG. 6—TRANSPORTING COLUMN THROUGH STREETS OF TOKYO

Telescopic Column Splices—One special requirement of the Tokyo building law that is framed with a view to providing maximum earthquake resistance is that at



splices in columns the abutting surfaces shall not be considered as transferring load, but that a riveted splice of sufficient strength to carry the entire stress shall be supplied. So far as this requirement has been lived up to heretofore, it has been done by putting outside splice plates at column joints, piling up these plates to the thickness necessary to provide sufficient area, and extending them a long distance each side of the splice, in order to provide sufficient rivets to develop them. This form of splice is very cumbersome and of little practical value as a protection against shocks. The column used on the Mitsui Main Building, however, lends itself admirably to a riveted splice. The splice plates are

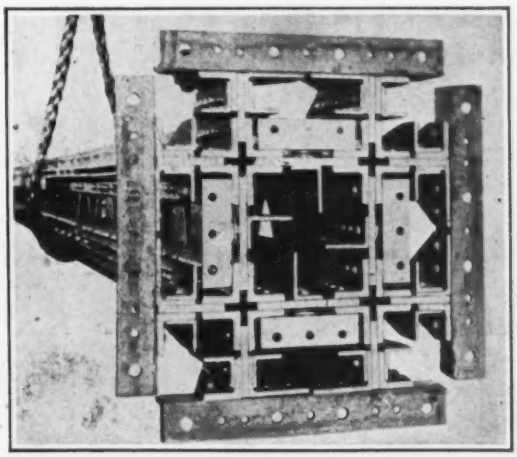


FIG. 8—BASE SECTION OF COLUMN

placed in the four planes of the column lacing, all the splicing rivets being in double shear. The first splice in all the large columns is located at the point of contraflexure between the first and second floors. Although theoretically no bending stress would have to be transferred at this point, nevertheless, by splicing the column angles at staggered points, the full value of the column was developed. The upper splices were designed in a similar manner, the loads being of course much smaller. Between the second and third floors, the splice was again

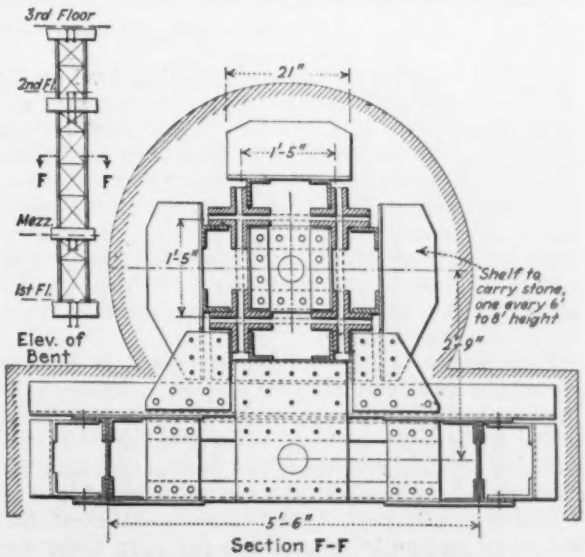


FIG. 7—TYPICAL INTERIOR COLUMN AND GIRDERS—SPECIAL FRONT-WALL COLUMN CONSTRUCTION

located at the point of contraflexure, but in the fourth story the bending moment was sufficiently small to place it a short distance above the floor line.

Another of the merits of this column is its adaptability to truss and girder connections, which develop very large bending moments. Fig. 7 shows how the double truss gusset plates in the planes of the lacing are entered between the column angles. Even by using 1-in. rivets in double shear, the connections were 6 ft. deep at the first and second floor, and 4 ft. deep at the basement. The same scheme, adapted to the simpler column section, was used on the upper floors.

Mention has been made of the high granite columns extending from the first to the third floor level on the three street fronts. Each of these contains a steel column similar to the interior ones. Adjacent to it, in the wall of the building proper, is a bent of two small plate-and-angle columns cross-braced against each other. This bent serves a triple function. It acts in place of the freestanding column to take its share of the horizontal shear in one direction; it braces the freestanding column against lateral deflection by means of diaphragms; it serves to support the masonry walls in the 42-ft. 6-in. story height.

Foundations—A reinforced-concrete mat is used to spread the load uniformly over the soil. Together with the reinforced-concrete retaining walls, this base forms a monolithic casing designed to resist hydrostatic pressure and to distribute evenly to the steel structure the shock of an earthquake. The soil under a test load of 4 tons per sq.ft. showed practically no settlement, but the actual loading is about 2 tons per sq.ft. under the whole of the building.

The mat is 4 ft. thick and was poured in seventy sections of about 800 sq.ft. each. The top and bottom deformed bar reinforcement is continuous through the construction joints, all of which are designed to key and dowel the sections together. In accordance with the Japanese law, every reinforcing rod has hooked ends. Elevator and sump pits and other depressions in the sub-basement floor are detailed in such a way as to preserve the mat thickness, and the bottom is beveled to minimize the effect of shock on the protuberances where these features occur.

Trowbridge and Livingston, of New York, are the architects of the Mitsui Main Building (as the bank is officially named), and James Stewart & Co., Inc., is the manager of construction. About 2,000 tons of steel were purchased from the American Bridge Co. and fabricated at its Ambridge plant. The remaining steel, about 8,000 tons, is being rolled at the Yawata Rolling Mills in Japan and is being fabricated by the Yokogawa Bridge Works and the Shimizu-Gumi Co. in Tokyo. All the shop details for both the American and Japanese shops were made by the consulting engineers, Weiskopf and Pickworth, of New York.

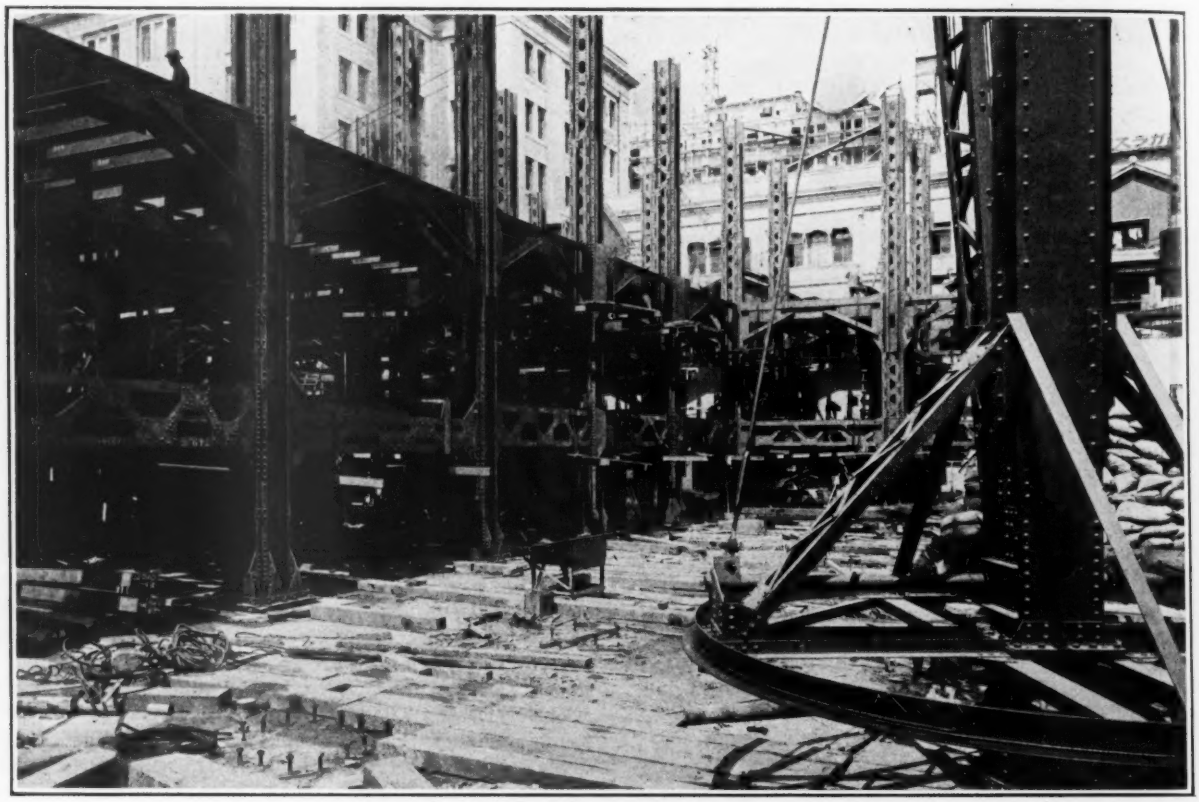


FIG. 9—STEEL FRAME TO MIDDLE OR BANKING-ROOM STORY

Motor Equipment for Road Maintenance

Approximately 43 per cent of the Wisconsin state trunk highway mileage is being maintained this year by motorized equipment according to a report of H. J. Kuelling, state highway engineer. It is stated that the advantage of this type of equipment lies in the ability to cover a greater mileage of road in a given time, while in most cases heavier work can be done than with team patrols. Teams are used where work requires them.

New Centrifugal Pumps Surpass Previous Efficiency Records

Detroit Units Show Overall Efficiencies of 84.7 Per Cent for 50-M.G.D. and 82.8 Per Cent for 70-M.G.D. Unit

By William Schwanhausser
Chief Engineer, Worthington Pump & Machinery Corporation, New York City

THE city of Detroit, through its Board of Water Commissioners, has put into service two 36-in. centrifugal pumps, one of which has proved on test to be the most efficient of its class. In some respects, the conditions to be met in designing and producing this equipment were quite as remarkable in their way as the overall efficiency result is itself unprecedented. It was specified that one of the pumps be able to deliver 50 and the other 70 m.g.d. per 24 hours, against 170-ft. head. It was also required that these pumps have the same casing and be so designed that the one of smaller capacity might later be converted to have a capacity equal to the larger with no change except the impeller. This, it will be recognized, involved a condition extremely difficult to meet, while at the same time producing a very high efficiency in both cases.

Maximum efficiency was desired, and conditions of the contract were so drawn as to insure the highest possible efficiency in the interests of low yearly operating expense. An overall efficiency of the combined electric motor and centrifugal pump of 80 per cent was required. A bonus was offered for each additional per cent efficiency over 80 per cent, up to a maximum of 85 per cent. A penalty was provided in equal

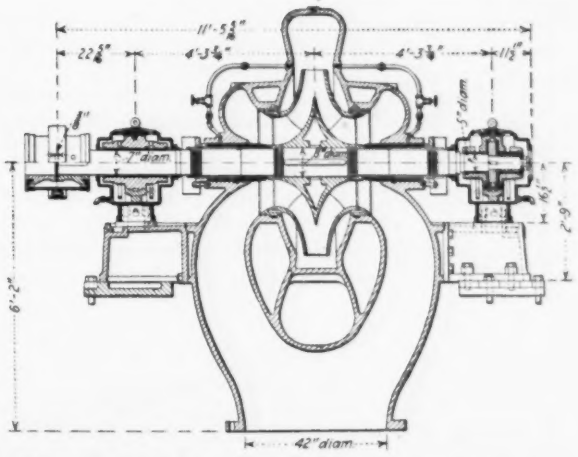


FIG. 1—SECTIONAL ELEVATION OF WORTHINGTON SPECIAL VOLUTE PUMP FOR DETROIT WATER-WORKS

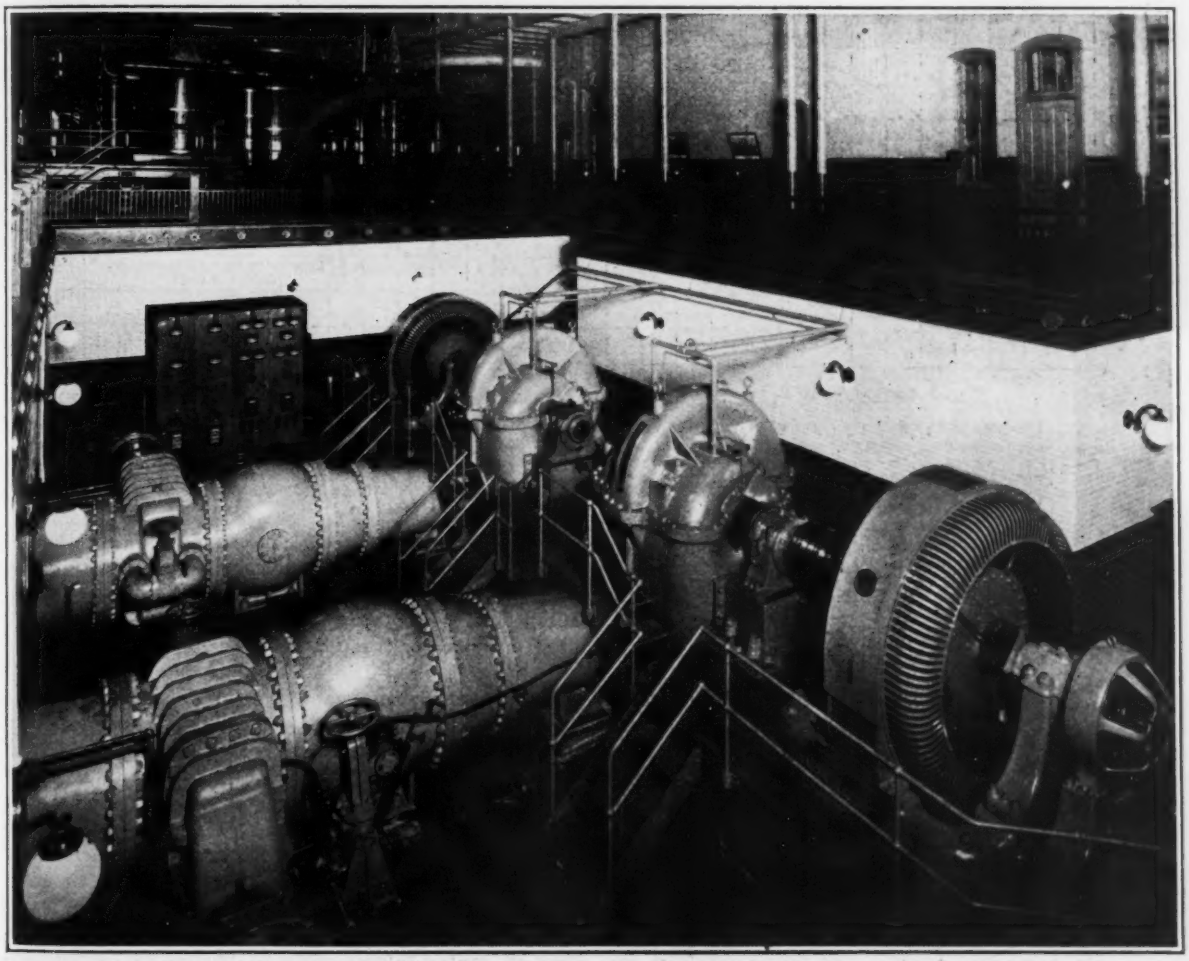


FIG. 2—THE 50- AND 75-M.G.D. MOTOR-DRIVEN WORTHINGTON CENTRIFUGAL PUMPS, DETROIT WATER-WORKS

amount for each per cent below 80 per cent, with an option on the part of the city of rejecting the units for any overall efficiency not exceeding 78 per cent.

The motors were of the synchronous type with direct-connected exciters, the motors running at 514 r.p.m. with full-load ratings of 2,050 hp. and 2,600 hp. respectively for the 50 and the 70-m.g.d. pumps.

In addition to the high efficiency required and the added difficulty of design in producing one pump casing for two materially different capacities such that runners could be changed from one to the other without materially changing efficiency, the contract provided for a third condition likewise difficult to meet. This was the short time available between the letting of the contract and its completion, considering the fact that new designs were necessary to meet the remarkable conditions stated. The early delivery required was the result of the city's need for the water as soon as it could be had to meet a water shortage condition. As a consequence, it was important that the time for the production and completion of the pumps be short, and that once the pumps had been started, no time be lost for alterations and adjustments. In other words, it was essential that the pumps should be able to meet the contract conditions, be in service at a specified time, and remain in service indefinitely.

The city selected the double-suction volute type of pump with horizontal shaft. The manufacturers decided that the most satisfactory way of developing the details of the design for these pumps would be through the adoption of the "model" system established in the engineering of hydraulic turbines. Accordingly, two steps were taken at the same time: (1) The immediate preparation of the details of design of the full-sized pumps on the basis of established experience; (2) the design and immediate construction of a geometrical model, to be tested in the shop, "similar, hydraulically, to the full-sized pumps."

For the model, two casings differing slightly one from the other, and two impellers likewise differing slightly, were constructed and tested. From the results of these tests two conclusions were drawn. The first of these involved the modification of the details of the full-sized pump, the main parts of which had been progressing through the shop in the meantime to meet time limits. The other conclusion was a prediction of the efficiency and horsepower characteristics of the full-sized pumps to be expected in the field.

In this way it was planned to secure the highest possible efficiency; the minimum time of production of a wholly new design, including its erection; and it was also expected that, with model data available, the pump when installed would not only perform as predicted, but that it could be kept in service as was desired by the city.

The units were tested in January, 1927, by William C. Rudd, assistant engineer of power, Detroit Department of Water Supply, with all parties concerned represented. The results of these tests are shown by the

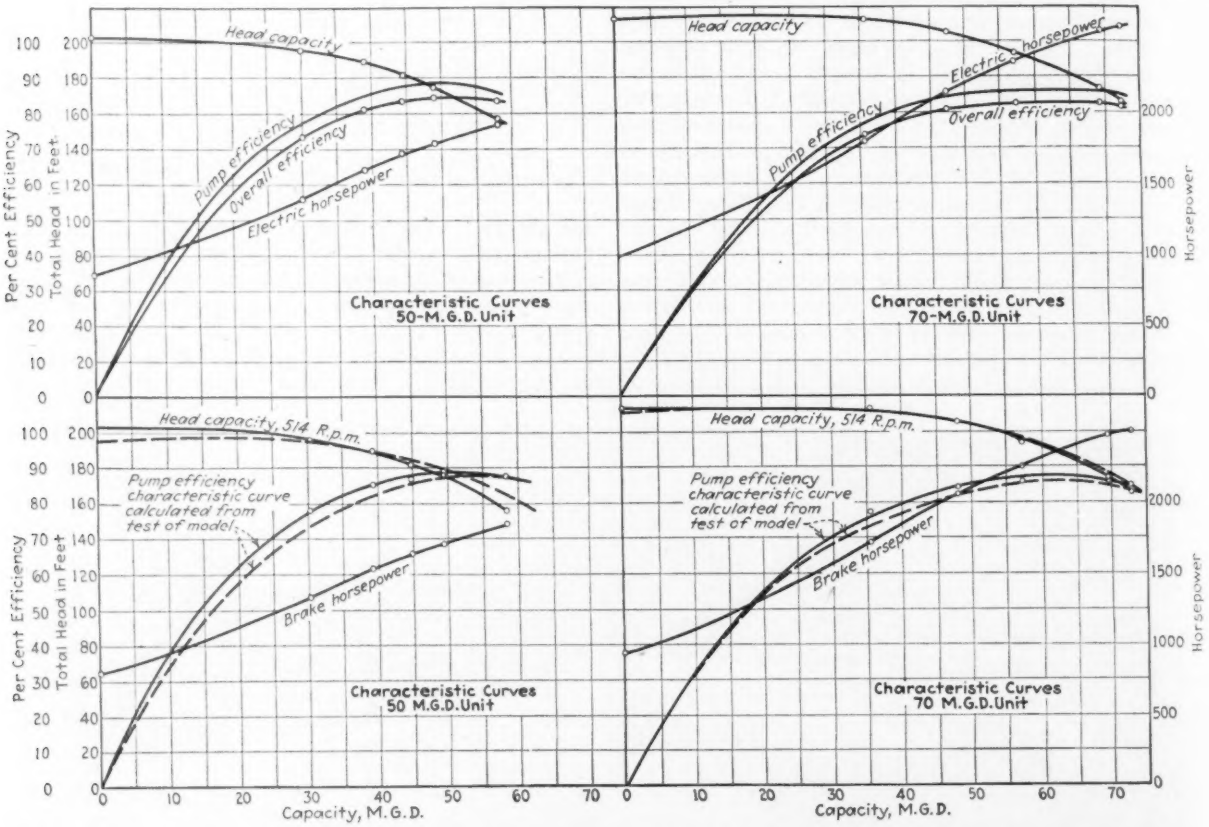


FIG. 3—CHARACTERISTIC CURVES SHOWN IN OFFICIAL AND IN MODEL TESTS FOR DETROIT CENTRIFUGAL PUMPS

Two upper diagrams show results of official acceptance tests, Jan. 21, 1927. The 50-m.g.d. unit when delivering at rated capacity against head of 174.29 ft. gave overall efficiency (pump and motor) of 84.7 per cent; pump only, 88.5 per cent. The 70-m.g.d. unit against 173.89-ft. head gave 82.8 per cent overall efficiency, and 86 per cent for pump alone. The two lower diagrams compare pump efficiencies under official tests and as calculated from tests of 10-in. models.

two sets of characteristic curves in Fig. 3. The 50-m.g.d. unit showed a maximum efficiency of pump and motor combined of 84.7 per cent and a pump efficiency based on test of motor of 88.5 per cent under the contract capacity rate and head of 170 ft. This is a world's record. The 70-m.g.d. units—the largest motor-driven water-works pump with respect to horsepower installed to date—showed a maximum combined efficiency of 82.7 per cent and a pump efficiency based on test of motors of 86 per cent, which is remarkably good considering the fact that the same casing carried a different runner to meet the requirements of the city for future additional capacity at a minimum of expense.

The direct value of the model construction and test procedure which obviated the necessity for any shop tests of the main units, except hydrostatic and balancing tests, and permitted the attainment in the field of the desired results is shown by comparing the characteristic curves of the model pump and the curves of the full-sized units obtained on official test (Fig. 3). These curves show that the performance of the 70-m.g.d. unit is practically coincident with the performance computed from the model. While the performance of the 50-m.g.d. unit departs somewhat from the model, the divergence was not unexpected under the circumstances and falls within the capacity of the designer to predict.

The pumps were produced and installed, with all appurtenances, by the Worthington Pump and Machinery Corporation. The General Electric Co. furnished the motor.

* * *

Supplementary Notes on Detroit Pumps

By W. C. Rudd
Mechanical Engineer, Detroit Water-Works

SEVERAL additional facts of interest to engineers may be stated briefly as follows:

The priming pipes of the main pumps are connected into the suction chambers and piped to an overhead closed vacuum tank. From this tank the pipe is brought down to two vacuum pumps. The vacuum pumps are of the Nash rotary type, driven by 220-volt, 3-phase, 60-cycle, 5-hp. motors. The vacuum in the tank is maintained at a predetermined point.

One of the vacuum pumps is started and stopped by an automatic vacuum switch. The vacuum pumps may be started manually, in case the vacuum switch fails to function. By means of this system both main pumps are kept automatically primed at all times. This is especially important in view of the fact that in case one pump is operating and suddenly fails to function, the other pump can be started quickly, since it is primed and ready for operation.

Another point that should be brought out is the fact that the motors are of the remote-control hand-start type with motor-operated switching equipment, the latter located in a switch house near the pit in which the pumps are installed. To start one of these large pumping units all that is necessary is to pull a small button-type switch on the switchboard located in the pit with the pumps. The control switchboard in the pit has no higher voltage than 220. The high-tension wiring that is enclosed in the switch house is 2,300-volt.

The power feeders for these two pumping units are three in number, so arranged that each pump has duplicate power feeders. Furthermore, these feeders are so arranged that the service can be secured from either one of two large electric power transformers. The power service is furnished by the Detroit Edison Co. at 24,000 volts and is transformed to 2,400 volts by means of two 7,000-kva. electric power transformers. These transformers are connected up on the low-tension side through a double-bus system, so that either transformer can be used independently of the other.

There is also installed in the pit with the two large pumping units, a motor-driven air-wash type of fan to force air up under the motors, air being brought in from the outside or the inside of the pump house. The capacity of this fan is 14,000 cu. ft. per minute.

All drainage in the pump pit is carried into a sump located in one corner of the pit and pumped from this sump to the sewer by an electric motor-driven centrifugal sump pump.

Another feature of this installation is the fact that the auxiliary power service for operation of the vacuum pumps, the fan and the sump pump is taken from the high-tension power lines to the main pump motors and transformed to 220 volts. The transformer for this purpose is located in the building that houses the high-tension switching equipment. This transformer is arranged to be used for duplicate power service.

In the switch house there is also located another transformer to transform current from 2,300 to 110 volts for use in the lighting system for the pump pit. This overhead lighting system is one of the interesting features of the installation. There are nine 1,000-watt lamps located about 65 ft. above the pumps. These lamps give a very satisfactory light for night-time operation.

The pump pit has a red tile floor and its walls are lined with tile brick.

Arc Welding Used in Reinforcing Australian Railway Bridges

Reinforcement of several old iron and steel bridges in Australia to carry the increased weight of railway traffic has recently been carried out with the help of arc welding. Some of the new locomotives on the South Australian Railway System exceed 200 tons in weight, which is considerably beyond the capacity of the bridges as originally built. The Hawthorne bridge over the Yarra River, a lattice truss structure with 150-ft. central span and 70-ft. side spans, was increased in capacity by making the spans continuous, and provision for the resulting reversal of stresses in the lattice members was made by welding on reinforcing tees and channels. A plate girder bridge of 27 spans 48 to 112 ft. long on the Victorian Rys., the Echuca bridge, required increase of flange section of the floorbeams and strengthening of web splices, reinforcement of the stringer connections and similar detail work. The strengthening of the floorbeams was done by welding on a flange plate on the top flange which had countersunk rivets, and welding on two 3x3x½-in. angles to the bottom flange. The two pieces of work were carried out under G. Kermode, chief engineer of the Victoria Public Works Department, and W. D. Chapman, of the Victorian Rys.

Construction of Oklahoma City's New Sewage Plants

With Special Regard to Water Handling and Concreting Plant Layouts as Used by the Contractors on Two Plants on Opposite Sides of the City

DIFFERING SOIL conditions and considerable difference in size of the two new sewage disposal plants now under construction for Oklahoma City have caused the contractors to resort to quite different methods of construction. Especially is this true of the concreting methods and the manner of handling ground water during the construction of the two-story settling tanks. Both contractors have developed efficient methods; this article will consider each construction procedure separately.

A rather high ridge, running east and west, divides Oklahoma City into two drainage areas, the one to the north draining into Deep Fork Creek, while the one to the south drains into the North Canadian River. There was thus a necessity for two sewage plants, one on the north side of this ridge, the other on the south side. These plants will be referred to as north plant and south plant.

The two plants have the same general design consisting of two-story settling tanks, sludge drying beds, and contact tanks for chlorine treatment. The design and general engineering features of these plants were described in *Engineering News-Record*, June 16, 1927, p. 976. This article will consider the construction methods for the two-story settling tanks at each plant since other construction was small and easily handled. There was some 18,000 ft. of sewer on the north plant contract, and 13,000 ft. on the south plant contract, the laying of none of which presented anything of unusual interest. On the south plant, which is more than six times the size of the north plant, occurred the larger problems and the more elaborate construction plan, although the contractor on the north plant perfected a very ingenious concreting plant.

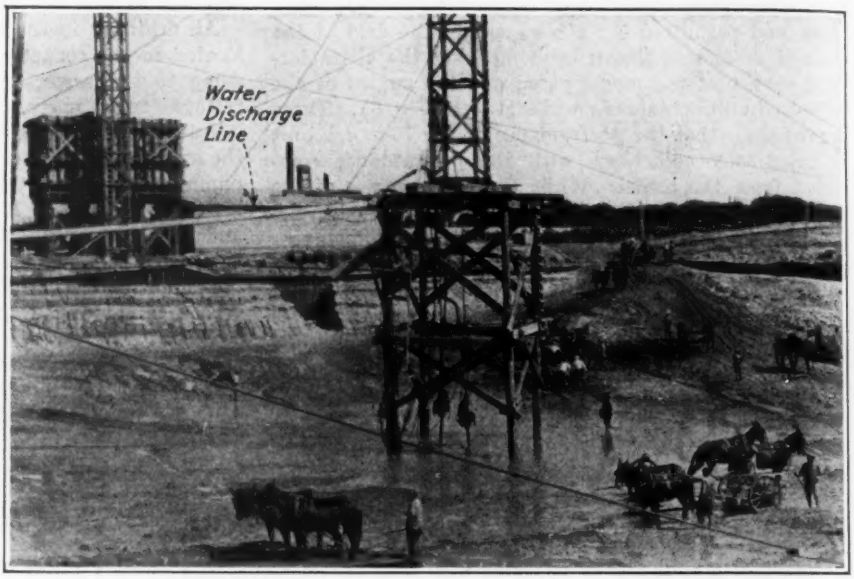


FIG. 2—EXCAVATING FOR SETTLING TANKS, SOUTH SEWAGE PLANT
Note how drainage is worked toward pump sump in center.

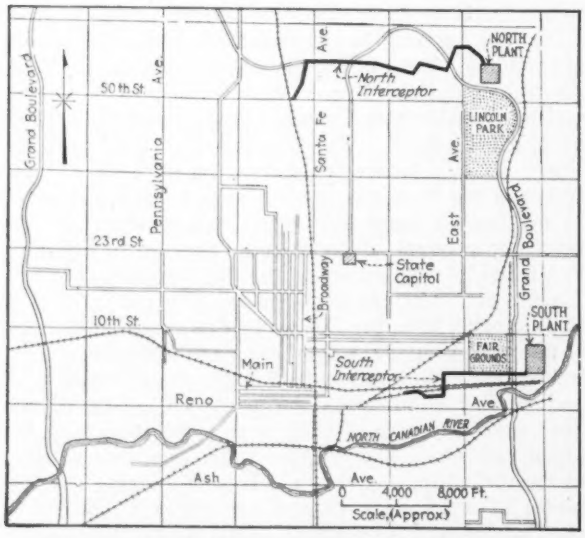


FIG. 1—LOCATION MAP FOR OKLAHOMA CITY'S NEW SEWAGE PLANTS

South Plant Construction

The south plant is located on practically the only rock location available at numerous possible sites. Even so, it is on land subject to inundation, and the entire site has been surrounded by an earthen dike formed from 30,000 yd. of the 52,000 yd. of material excavated from the tank locations. The water level is at El. 87, which is 5 ft. below ground. Shale was struck at El. 71, and the hopper bottoms of the tanks are excavated 11 ft. into the shale. Thus, the tank site is mostly below ground water level, and some method had to be devised to take care of the water. First a steel sheetpiling cofferdam enclosing the tank site was driven 250x270 ft. in plan and about 22 ft. to shale. Crossbracing in the cofferdam being out of the question, some special method of holding the sheetpiling in place was necessary. The cofferdam was made large enough so that the earth could be sloped 2 to 1 on the inside from nearly the top of the driven sheetpiling to the edge of the hole for the tank locations. At the top of the sheetpiling a 6 x 12-in. waler was fastened entirely around the cofferdam, anchored away from the hole every 7½ ft. by a ½-in. cable 45 ft. long fastened to a 4-ft. pile stub,

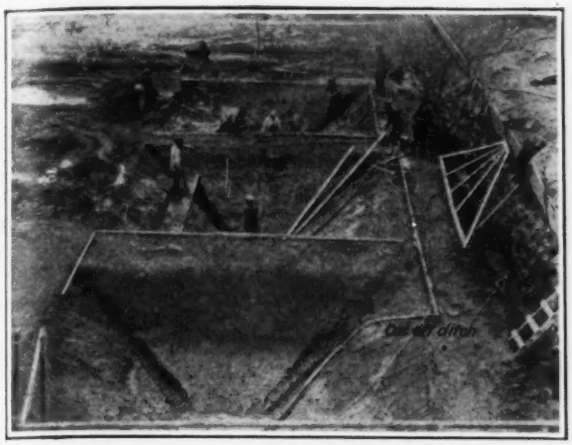


FIG. 3—EXCAVATING HOPPER BOTTOMS FOR SETTLING TANKS, SOUTH PLANT
Water handled by hose from each hopper.

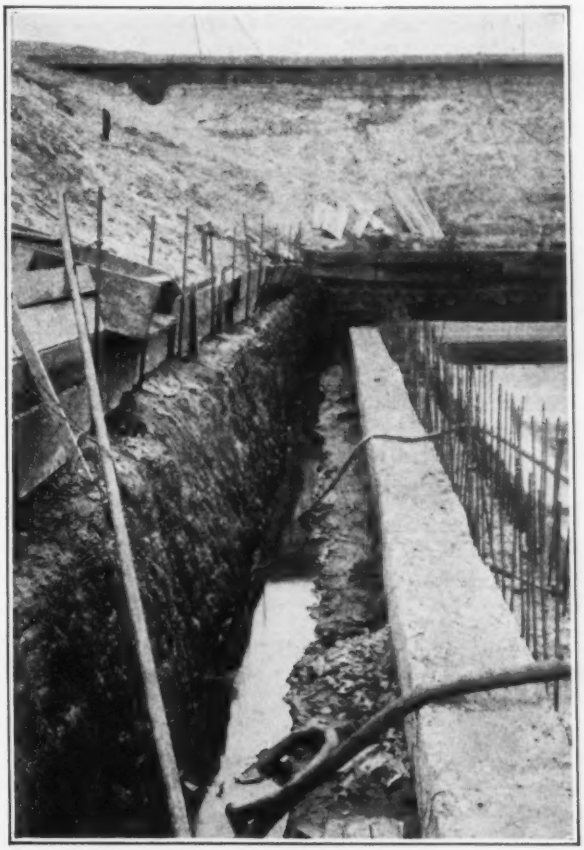


FIG. 4—DRAINAGE CUTOFF DITCH ENTIRELY AROUND TANK SITE, SOUTH PLANT
Note sheetpiling in background braced by 2:1 earth slope toward tanks.

For handling the water, a sump was dug in the center of the cofferdam and a tower erected over it to support the water discharge line. This tower was later used to support another tower carrying the concreting chutes. All excavation, 52,000 yd., was done by teams using fresnos and wheelers, care being always used to keep the bottom draining toward the sump, Fig. 2. After reaching the shale and sandrock, a trench was dug completely around the tank site, Fig. 4, draining at its lowest point to a cross-ditch which led to the sump in the center. This cutoff ditch system kept all outside water from the tank hopper excavations. Since the hopper bottoms as stated were below ground water level, a 2-in. hose connected to a small two-cylinder steam pump was run from each of the 36 hoppers to the center sump in order to take care of what water was present in these sections of the excavation. Incidentally this was a very small portion of the total water handled. On the end of each of these lengths of hose was placed a 2-in. pipe which penetrated a stone fill below the hopper bottom. Flap valves were placed in the bottom of the hoppers so that when the hydrostatic head is greater outside than inside the ground water can enter and equalize the pressure. Out of the center sump four pulsometer pumps—one 4-in. and three 2-in.—discharged the water into a 10-in. galvanized line

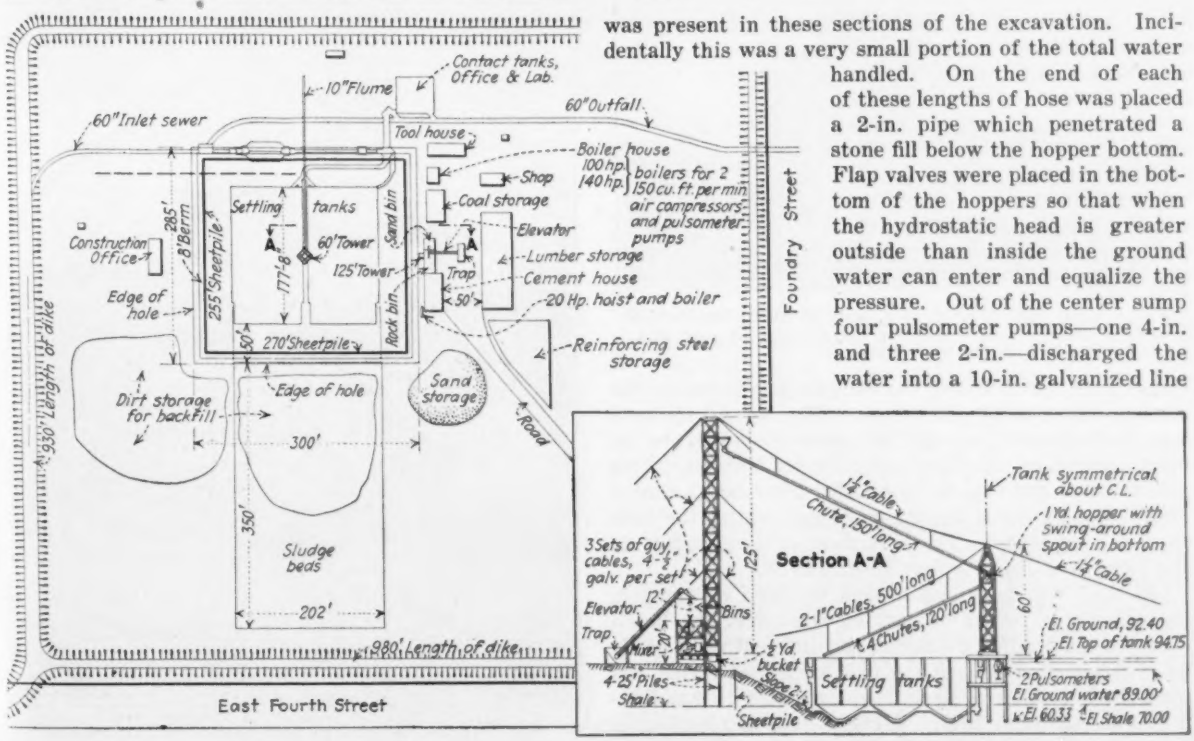


FIG. 5—CONTRACTOR'S PLANT LAYOUT AT SOUTH SEWAGE PLANT, OKLAHOMA CITY

suspended from the tower to the edge of the excavation and discharging outside of the levee.

The plan and elevation of the concreting plant, Fig. 5, show how the concrete was distributed. The sand and stone were brought to the site by truck and dumped through an elevated trap to a steel hopper feeding a bucket conveyor with a 50-ton-per-hour capacity. This bucket conveyor was operated by a 9-hp. two-cylinder gasoline engine situated on top of the aggregate bins. These bins were of 100-yd. capacity for the sand and 200-yd. for the stone. Fig. 7 shows the charging floor at cement shed level. The arrangement used proved very efficient. The sand hopper on the right and the stone on the left were emptied through counterweight doors of the contractor's design. The doors open down, forming a chute. A runway from the cement shed permitted the cement to be carted to piles on the charging floor. The mixer was a 14-S machine operated by a four-cylinder gasoline engine.

A 125-ft. elevator tower raised the concrete to the

FIG. 6—CONCRETING PLANT, SOUTH SEWAGE PLANT
Incline and elevated trap for truck dumping of sand and stone onto bucket elevator hopper.

main chute which led to the distributing tower in the center built over the sump tower, Fig. 8. All concrete was chuted from this tower into counterbalanced chutes, except that used for the sloping hopper bottoms. This was too stiff and had to be wheeled after being chuted direct to a receiving hopper on a platform at the base of the sump tower. The maximum chuting radius to the corners of the site was about 140 ft.

All steel was bent and hooked by hand on the job. By using pipe collars of varying sizes over the bench studs on the bending machines, the different radii bends were obtained as desired. A unit system of forms was used, each section designed for one man to handle—3 ft. wide and 14 ft. high. Vertical studs and horizontal holdbacks, the whole fastened together by clamps, completed the forms. The forms were detailed in the office

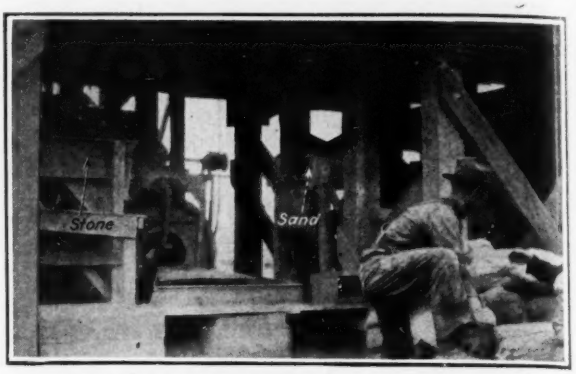


FIG. 7—CHARGING FLOOR FOR CONCRETE MIXING AT SOUTH PLANT

and made in the shop on the job. About 300 ft.b.m. of lumber was used. The equipment in the shop included a saw table, a swing cutoff saw, a drill press, emery wheels, and grindstones, all operated through belt-driven countershafts by a 2-cylinder, 9-hp. gasoline engine. Steam for the pumps was generated at the boiler house by two boilers, one of 100-hp., and the other of 140-hp., capacity. Two steam-driven air compressors of 150-cu.ft.-per-minute capacity were also located in the boiler house. When extra air was needed it was

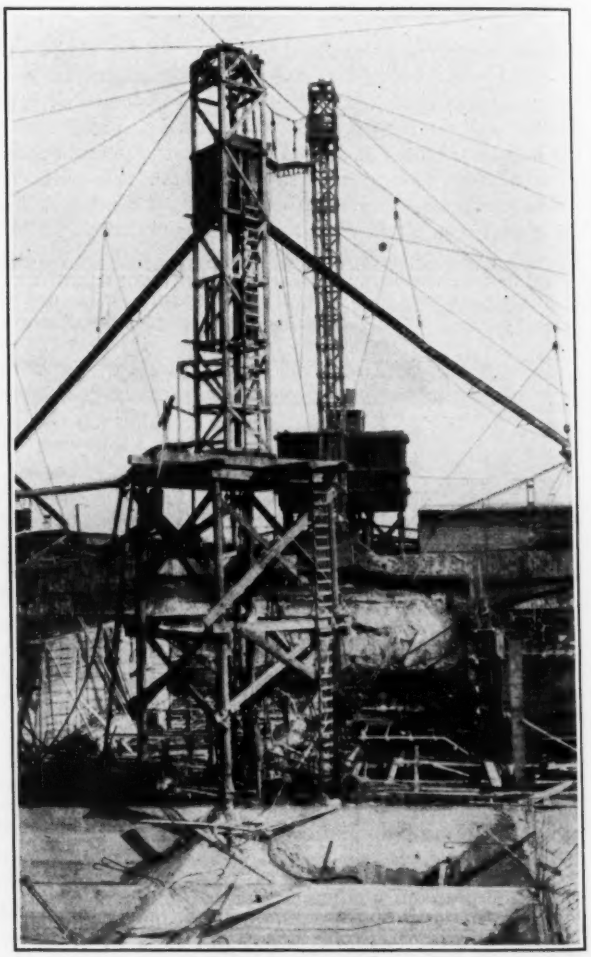


FIG. 8—CONCRETING IN PROGRESS, SOUTH PLANT
125-ft. elevating tower at mixing plant chutes to distributing tower over center sump tower. Hopper bottoms in foreground.

supplied by two gasoline-engine-driven compressors of 110- and 170-cu.ft.-per-min. capacity respectively.

The Boardman Co., engineers and contractors, Oklahoma City, with R. F. Thompson, engineer in charge, and H. C. Skaggs, superintendent, is building this plant.

North Plant Construction

The construction of the north-side plant, which was much smaller than the south plant, 60x90 ft. being the area of the tanks, was characterized by a unique concreting plant and efficient water handling. The ground on this site was a porous, mealy clay, through which water travels easily. As in the south-side plant, a gravel bed about 18 in. deep, covering the bottom of the hopper tank, was used to catch the ground water, and flap valves were provided in these hoppers to equalize hydrostatic pressures from the ground water. Perforated 6-in. galvanized pipes were set into the gravel bed. Inside of this a well point was inserted and attached to a 2-in. pipe leading to the outside. Each pipe from each hopper was arranged similarly and all connected to the suction of a double-plunger trench pump placed outside the tank. This pump, with a 4-in. suction and a 5-in. discharge, at 300 g.p.m., dewatered all of the tanks.

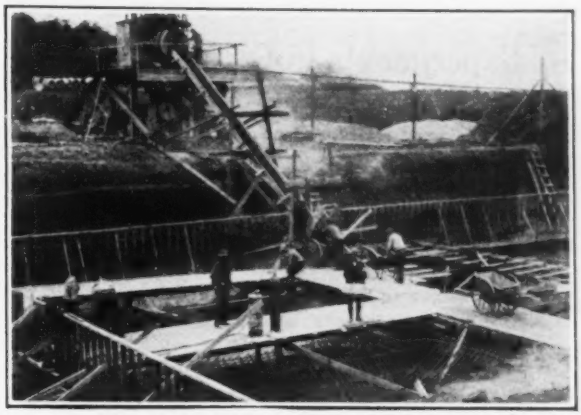


FIG. 11—CONCRETING HOPPER BOTTOMS, NORTH PLANT

FIG. 10—CONCRETE MIXING LAYOUT, NORTH PLANT

Old steam paver converted to motor drive and charged by incline-skip bucket. At right, skip bucket in loading pit below ground level.

The contractor built a very efficient concreting plant using the drum and gears from an old 21-E steam paver. To a tank on a platform over the drum, water was supplied from a well driven on the site and pumped with a duplex plunger pump, belt-driven from a 1-hp. electric motor. The mixer drum was driven from a 10-hp. electric motor belt-connected to the old steam-drive shaft of the drum. All equipment was motor-driven.

A 14-cu. ft. skip operating on an incline and connected to the old skip hoist on the mixer charged the drum. As shown at the right in Fig. 10, this skip when at the bottom of the incline was in a pit below ground level. Wheelbarrows could thus be dumped directly into the skip from runway planks on the ground. Platforms all around the hopper tanks were provided as buggy runways for concrete distribution. The arrangement worked quite satisfactorily, and turned out concrete as fast as it could be wheeled around the runways. Leo C. Sanders, Oklahoma City, is north plant contractor.

All sewage work is under the personal direction of B. M. Hart, city engineer. Samuel Greeley, of Pearse, Greeley & Hansen, Chicago, Ill., is consulting engineer.

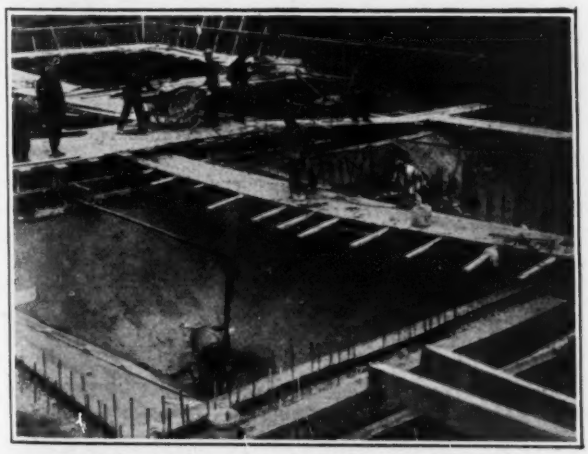


FIG. 9—WATER HANDLING AND CONCRETING IN HOPPER BOTTOMS, NORTH PLANT

Kovno Bridge Competition Decided

In the competition for a bridge over the Niemen River at Kovno, Lithuania, the first prize was awarded to the Skoda Works, Pilsen, Czechoslovakia, in co-operation with Dyckerhoff & Widman Co., Biebrich, Germany. Second prize was awarded to Ceskomoravska-Kolben Works, Prof. G. G. Krivoshein and B. Hübschmann, architect, all of Prague, Czechoslovakia. Third prize was awarded to the Siemens Bau Union of Berlin, Germany.

Experiments in Crack Control in Concrete Roads

Experience With Reinforcement and With Cross Joints—Planes of Weakness Tried—Panel Construction Coming Into Use

By C. N. Conner
Highway Research Board, Washington, D. C.

MANY concrete roads have cracked and they are continuing to crack. As the amount and character of this cracking are generally accepted as a measure of the life and usefulness of the pavement, anything which can economically be done to reduce and control them should receive serious consideration. The causes of the cracking have been named as everything from the subgrade to the sun in the skies. Whatever these causes may be, engineers in both science and industry have labored to find the remedies, and it can be fairly stated that appreciable progress has been made.

In the past five years there has been accepted a radical change in the cross-section of pavement, so that today we find very few who will use anything but the uniform-depth or the thickened-edge cross-sections. Greater uniformity in the mix and texture of the finished pavement is being secured by new and improved methods of proportioning aggregates by weight, by inundation and by a wider use of the water-cement-ratio theory. Much smoother riding qualities and reduction of impact stresses are evident as a result of improved and more careful methods of surface finishing. New methods of curing such as the prompt use of wet burlap have been accepted as have also certain admixtures for obtaining plasticity or high early strength. The safe date for opening a pavement to traffic may be estimated at the roadside instead of in the laboratory by testing in flexure small cantilever beams which have been made of concrete deposited on the subgrade.

All of these improvements in design and construction are resulting in better concrete pavements, but they cannot be expected entirely to overcome the primary causes of cracking, which are variations in temperature, in moisture, in subgrade, and in traffic. There are two principal and outstanding means for controlling cracks in concrete roads: (1) The use of steel reinforcement, and (2) the use of longitudinal and transverse joints. Although some features of both reinforcement and joints need further study and research, many engineers have not taken full advantage of, nor have they used, the information which is available.

Reinforcement—Reinforcement has been used in concrete pavements for at least 15 years. While most road builders felt that it added real value to a pavement, they were obliged to base the reason for their conclusions on the behavior of isolated pavements which happened to come within the scope of their personal observation. It was not until after the investigations and report of C. A. Hogentogler were published in 1926 that a clearer understanding of the whole subject was made possible.

The principal method of making this field investigation, from which the conclusions of the report were drawn, was by direct comparisons of adjacent sections of plain and reinforced-concrete pavements. The conclusions drawn from the data collected show, among other pertinent facts, that steel reinforcement reduces the rate of cracking and thus increases the life of the pavement. They show that a greater reduction (in cracking) is afforded by small steel members closely spaced than by larger members wider spaced; that all types of steel reinforcement across cracks tend to hold together fractured slabs; that bar reinforcement across transverse joints, without proper provision for slippage and clearance, results in breakage and subsequent expensive repairs, and that for long slabs, 75 to 100 ft. or over, edge-bar reinforcement with continuous bond causes corner cracks if the area of steel exceeds ¼ sq.in.

A digest of the conclusions in this report serves not only to confirm claims which have been made for reinforcement, but to invite attention to conditions which have not been generally investigated, and which may have an appreciable influence on the life of concrete pavements. Among these are the delay and reduction of shrinkage cracks which often appear during and immediately after the setting-up period. It is indicated at least that a proper distribution of reinforcement in comparatively small amounts will reduce these early shrinkage cracks. These small shrinkage cracks in all probability are a source of weakness to a pavement surface. Roads in service also showed that in relatively short slabs (20 to 75 ft.) all types of two-way reinforcement were effective against cracking and separation of cracked slabs, and that, weight for weight, small members closely spaced were more effective than large members spaced farther apart. Another important indication was the impracticability of having steel in bond function over considerable lengths (more than 100 ft.). This was evidenced in both bar and mesh reinforcement by cracks and raveling appearing at definite intervals. Steel bars that allowed a relatively large concentration of steel in bond when used either transversely or longitudinally were apparently another cause of cracking.

Use of Joints—The use of joints to prevent irregular and raveling cracks dates back as far at least as the use of reinforcement for the same purpose. Like reinforcement, their popularity has come and gone only to return again, showing that they also have a real value in concrete road construction.

The early types of structural steel shapes where used as joint material probably did more harm than good and were one of the contributing factors toward discouraging the use of joints in general. The apparent inability of some contractors to build a smooth riding pavement containing any type of joint and the additional cost to the owner did not increase their popularity.

Although no extensive and correlated field investigation and report on the economic value of roadway joints has ever been made, sufficient information is available to permit some fairly definite conclusions. The object of any type of joint is to control and regulate to a definite minimum the spacing of transverse and longitudinal cracks, and to prevent the formation of diagonal cracks.

Real progress has been made toward this objective. The first step was the installation of a bituminous or metal plate which divided the pavement from its surface to the subgrade. This method of joint installation has been in use for several years and while it

has done much to accomplish a reduction in cracking, its cost, inconvenience of installation, and delay to the progress of work has prevented some sections of the country from adopting it. The longitudinal joint is far more popular than the transverse for it not only minimizes longitudinal cracking but also, when well defined, serves as a permanent center line marker for dividing traffic. Some of the virtues of the transverse joint are readily admitted, but their use has not been generally accepted; instead, many engineers are willing to accept transverse contraction cracks although they are more irregular and their minimum spacing and tendency to ravel are difficult to control.

Planes of Weakness—As a departure from the older methods, a new, and by present indication, satisfactory system of crack control which costs but little and accomplishes the desired results is receiving deserved attention. This is the plane of weakness or "dummy" joint as some have termed it. The idea of this method probably was conceived through the satisfactory results obtained by using grooves or planes of weakness in concrete sidewalk construction; at any rate, it has been tried out in different parts of the country on rural highways and city pavements by engineers acting on independently conceived ideas

The state of North Carolina has built a test section of reinforced-concrete pavement in which transverse planes of weakness are introduced every 40 ft., so that the slab will crack and divide itself, thus dispensing with a premoulded joint. The writer was personally responsible for this piece of work while construction engineer in that state. A subsequent inspection showed but one transverse and no longitudinal cracks in the 2,000 ft. of test section after 18 months of service. Other sections of pavement laid under the same contract showed diagonal longitudinal and transverse cracks. Some of the transverse cracks were as close together as 5 ft. Observations during construction showed that the 2-in. grooves opened up to the subgrade within 24 hours after placing the concrete. Reinforcement was stopped 6 in. each side of every plane of weakness.

The groove or depression was obtained by using a battered wood strip of ½-in. top and ¼-in. bottom thickness, and 2-in. depth equal in length to the pavement width. This strip was forced into the concrete flush with the surface, and then withdrawn, leaving the desired groove whose top edges were finished smooth; the entire groove was later filled with tar.

In Seattle, Wash., a similar construction has been adopted. The slot or groove was formed by using a chalk line to mark its position and then driving a 2-in. T-iron about 6 ft. long into the concrete with a sledge hammer. This piece of pavement, whose 30 ft. of width is thus divided into two 15-ft. strips by the longitudinal "dummy" joint, is said to show no longitudinal cracks. Other Seattle pavements 25 ft. in width and laid at a later date without any longitudinal joints, have cracked in a longitudinal direction. The city is now using this method for both longitudinal and transverse joints with satisfactory results.

This method of joint construction has been tried out or accepted by several states, including Delaware, Pennsylvania, Michigan, Missouri and California.

As is frequently the case in all pavement construction, machine methods are replacing hand methods for producing these joints. This machine consists of a steel frame which travels over the forms on wheels. It can be accurately and easily adjusted to varying widths of pavement, widened and superelevated curves, varying slopes of surface and crown, and it is equipped to make both longitudinal and transverse grooves. The grooves are formed by the machine forcing a V-shaped joint plate into the concrete surface; this is quickly and easily withdrawn. After edging with a trowel and belting with the belt attached to the machine, a neat and permanent groove is left in the pavement. This groove is then poured with bitumen. Because of the accuracy of the machine work, the resulting grooves are generally neater in appearance and straighter than those obtained by using steel center plates.

Bureau of Roads Tests—Aside from the fact that some have already adopted the combined use of fabric reinforcement and joints for the control of cracks, it should be stated that the U. S. Bureau of Public Roads is conducting experiments on slabs at Arlington, Virginia. The objects of this experiment are to determine:

(1) Comparative effect of different methods of curing.

(2) Effect of steel reinforcing of various types and weights in distributing stresses occurring from shrinkage in the concrete.

(3) The effect of expansion joints in distributing stresses occurring from shrinkage in the concrete.

(4) The effect of moisture in the subgrade in reducing shrinkage cracking.

(5) The effect and prevention of rapid drying of the newly placed concrete.

(6) The magnitude and effect of subgrade resistance.

(7) The curing of concrete pavements.

(8) Possible relation between pavement behavior and test data from control specimens.

Another experiment is being conducted by the State Highway Department of Virginia in conjunction with the U. S. Bureau of Public Roads. This is a construction project on one of the main highways. There are a considerable number of test or demonstration sections of 18-ft. concrete pavement. Besides including various methods of finish, admixtures, and subgrade treatment, there are sections which contain planes of weakness or "dummy" joints. Some of the sections contain the longitudinal plane only, while others contain both the longitudinal and the transverse. It is understood that welded mesh fabric is being used in some of the sections in addition to the planes of weakness.

Combined Reinforcement and Joints—While each of these methods for controlling cracks has much merit, their combination using small steel reinforcing members at a fairly close spacing, together with "dummy" joints, will be most effective toward reducing early and late cracking.

Many of the older specifications admit either bars or welded steel fabric for reinforcement; some use a combination of fabric with steel marginal bars, while still others use the marginal bars only. During the past year, however, there appears a tendency toward a wider use of welded steel fabric. There are several good reasons for this, such as the fact that fabric is now being furnished with heavy marginal wires which give a better distribution of marginal steel, ease of handling and the efficient distribution of steel with, of course, a maximum bonding area. There are, however, some points which must be considered wherever rein-

forcement and joints are used in combination. From field observations by Professor Eno, the vertical displacement of pavements has been found to be an appreciable and in some cases an alarming amount. A pavement subdivided by planes of weakness and strengthened by reinforcement is certainly indicated in such places. Construction of a pavement creates tensile stresses which cannot be resisted by concrete, the planes of weakness will open up and relieve the concrete of much of this stress. The spacing of these planes should range from 20 to 60 ft., depending on the coefficient of friction of the slab upon the subgrade. A high coefficient of friction will call for the closer spacing to prevent intermediate cracking, whereas a wider spacing could be used on a smooth, uniform subgrade such as the soil in Illinois, where transverse cracks are infrequent.

The plane of weakness may or may not be of assistance in preventing blow-ups, caused by expansion. Much of this compressive stress is doubtless absorbed by the pavement itself and its friction on the subgrade. The full depth joint with bituminous filler placed at wide intervals of say 1,000 ft. might assist, but we still have much to learn about the cause of and remedies for blow-ups.

Transverse joints of any type give better results when kept in line by slip dowels with end clearance. These dowels should be encased, oiled or greased for at least half their embedded length to allow adjacent sections of pavement to separate during contraction. They should have end clearance, to prevent their buckling and destroying the adjacent concrete when the pavement expands. The reinforcement should be stopped about 3 in. from the planes of weakness, to allow the end to open up during contraction of the pavement.

Longitudinal joints may or may not be tied together by reinforcing fabric or dowels, depending on the probability of lateral displacement due to subgrade conditions. The transverse members of the fabric can safely extend through the longitudinal joint for average conditions or they may be assisted by the addition of short dowel bars, in bond, for anticipated conditions of lateral displacement.

In this combination of joints and reinforcing, we are approaching a pavement condition which is made up of a number of panels or units. Because of the flexibility of their joints and the individual strength of each unit, they tend to adjust themselves, without undue stress, to varying conditions of temperature, moisture, climate and traffic. Each unit also has sufficient area and strength to bridge over the weak spots of non-uniform subgrade.

Many Automobile Fires on Bridge

Statistics of automobile fires on the Manhattan bridge recently compiled by E. A. Byrne, chief engineer of the Department of Plant and Structures, New York City, show a total of nearly 200 such fires in two years. The figures, separated for trucks and passenger cars, are:

Year	Trucks	Passenger Automobiles	Total
1925	59	7	66
1926	84	29	113
Total	143	36	179

These figures apply to fires originating in the vehicle itself. Fewer such fires occur on the Brooklyn, Williamsburg, and Queensboro bridges, which do not carry so heavy a truck traffic.

Italy's Economic Situation

By E. J. Mehren
Vice-President, McGraw-Hill Publishing Co., Inc.

Milan, Italy,
May 30, 1927

SO MUCH has been written lately about Italy and Italian conditions that one is in danger of repeating what is already well known in the United States. But in this article the emphasis will be laid on the economic and industrial situations: the political and social naturally get most attention. Even in an economic discussion the political and social conditions cannot be excluded. The social situation, in particular, forces itself on the attention of the visitor. It is the outward spirit of the new Italy; it permeates the atmosphere and colors every contact that one has on the streets, in offices, in railway trains.

The New Italy—Before proceeding to the economic situation let one instance of this spirit be given. Coming by motor over the Simplon Pass we picked up two punctures near the border. Changing one tire, we limped into Domo d'Ossola by pumping the other at intermediate points. Our first need, therefore, was a garage, so we stopped at a corner cafe (the respectable European brother of the former American saloon) to make inquiry. After getting directions and arranging to send the car to the garage I reached for my overcoat lying on top of the luggage. Immediately our informant remarked that in Italy I need not worry; the coat would be safe; and this man had an understanding of my mind for he had spent six years in America. What he said was brief, but it was said with pride and confidence.

This note, struck at our very entrance to Italy, has recurred again and again. Socially, Italy is a new land. Its people are conscious of the change and show their pride. Underneath there may be—there undoubtedly is—grave reservation as to the need or wisdom of the methods that have been employed; but, for the obtaining of results, "the plan works," and to the hurried traveler all looks placid.

Economic Situation—As to economic conditions, it is clearly evident that prosperity reigns; having seen Western Europe, including Germany, in the low ebb of 1920 the difference is apparent. The people on the whole are well dressed and have a confident bearing. The latter point is important; judged by the economic experience of other countries, Italy should now be under severe economic distress. A year and a half ago the lira stood at 30 to the dollar. Now it is 18½. It has gone from, say 3⅓c. to 5½. The usual accompaniment of such a rise is the falling off in buying power and a decline in exports, resulting in a decrease in demand on industry, unemployment and the usual accompanying distress.

These phenomena are not absent here now, but, as yet, there is not a crisis. There has been export decline, but it is slight. There is unemployment, but not serious, though a goodly number of factories are on a part-time basis. Possibly the best general index is that of electric-power sales. While the annual increase in sales since the beginning of prosperity under the Mussolini regime has been at the rate of 10 per cent, the increase in the first four months of this year over the corre-

sponding period of last year has been about 3½ per cent. The rise in the lira, then, has slowed down development but not precipitated a crisis.

This improvement in the value of the lira was a cause for congratulation on the part of Mussolini in opening the Parliament last Thursday (May 26). It was said two years ago that Fascism had lost the economic battle—the "battle of the lira"—even though it might have triumphed in other fields. For that reason the Prime Minister had directed the minister of finance, Volpi, to take all needed steps to improve the financial position. The objective has been attained, said the Duce on Thursday; Fascism had demonstrated that in this field, too, it was equal to the situation.

Does a Crisis Impend?—Naturally, the big question is as to the future of the lira. Some feel that it has improved too rapidly; they would, in fact, like to see it slip back so that export and tourist trade would be encouraged. Evidently Mussolini is fully aware of the situation. Using military phraseology, he said that they had captured Hill 90 (90 lira to the pound sterling) and would rest there to reconnoiter their position. In other words, the future campaign will be determined by the results of this one; and the results are not yet fully apparent.

What the future holds economically even with the lira held at its present position is not clear. Some predict a more serious situation, maintaining that the full effect of the increased valuation is only now beginning to be felt; until now goods have been shipped on contracts made before the rise. New orders, on the new value of the lira, are not coming in in so large a volume. On the other hand, there are men of affairs who believe that the present political regime will adopt measures—and successfully enforce them—that will prevent serious distress.

Wage and Price Reductions—The crux of any situation like this is that prices are not reduced in proportion to the increase in value of the exchange medium. The fascist regime is now tackling this point. As of June 1, the salaries and wages of all in the national government service will be reduced 10 per cent; this includes the wages of post office and railway employees. Through the Union of Confederations of Industry, the industries will be requested to make a similar reduction.

But wage reductions alone would virtually increase the cost of living, by reducing the purchasing power of the worker. Therefore, there have been decreed compulsory decreases in rent and in food necessities. Rent, now from five to seven times pre-war prices, must be reduced to four times the pre-war basis. Milk, bread, rice, macaroni (and its various brothers) and meat have been reduced 10 per cent. The enforcement is very severe, and precautions are taken that the law is not evaded by decreasing quality. Last week, in Milan, eighteen shops were closed for not complying with the law. Going still further, the communes are co-operating and have requested all merchants to make general reductions in prices. The shop windows in the cities and towns are almost all displaying reduction signs; and the reductions range, so the signs say, up to 30 per cent. The hotels have put into effect a 10 per cent reduction and hope, they say, to make further reductions. Here necessity has been an added spur; the tourist travel had fallen off. Obviously, the 10 per cent decrease is out of all proportion to the increase in the value of the lira; even the sharp recent increase has been 40 per cent. A beginning, however, has been made, and those who believe that a sharp crisis will be avoided look forward to a repetition of the recent price and wage reductions.

Incidentally, these wage reductions may well be a test of the strength of the Mussolini regime. It is easier to hold the multitude on a rising market than to lead them backward. True, price reductions may hold the purchasing power even, but cash in hand means more to the un-lettered than purchasing power. Nevertheless, the fulsome advertising in the press, by commune proclamations, by displays in shop windows, by general conversation constitutes a mass campaign of education that may impress everyone. One card is up the Premier's sleeve. With the control he has he could let the lira slip back again, and start a buying boom. So, all in all, the situation would seem to be in hand, even though the stage is set for economic stress just now.

Italy's General Position—But no matter what the immediate situation, Italy has a difficult economic position. To state it is but to recall what every informed American knows. She lacks natural resources, her soil cannot now support her people, she lacks the capital resources to industrialize rapidly enough to give employment to a rapidly increasing population. Before the war her surplus population emigrated, principally to the United States; she has not yet created the mental conditions to avail herself of other outlets—South America, and possibly Canada. She came out of the war with a high per-capita debt charge that necessarily will go on for more than a generation. Yet she has a population of marked intelligence, capable, if there were opportunity, of playing a great industrial rôle. She must industrialize—that is the law of the present-day world; but on that industrialization are placed the handicaps previously referred to. Just now, her trade balance is adverse yet she has large payments to make on war debts. Nevertheless, she is borrowing abroad money that will require a still greater excess of exports in order to pay the interest and, when the time comes, the principal. American bankers alone have loaned Italy, the government, Rome, Milan and industries about $277,000,000 in less than two years.

The task involved is no small one. Italy's "way out" is to cut down her standard of living—she is on "war bread" again, for example—to reclaim her swamp and arid lands and to develop her hydro-electric power. Thus she will cut down her imports of foodstuffs and coal. To increase her export side, she plans further industrialization, and is building a great merchant marine which will build up her "invisible exports." Though the task is large, the outlook is not impossible judged by Italy's pre-war financial position. She then had an unfavorable trade balance of 1.2 billion lira, but this was balanced by tourist expenditures in Italy, remittances from Italians resident abroad and receipts from shipping. In addition, between the years 1890 and 1913 she bought back 6 billion lira of Italian government bonds held abroad.

Therefore, despite her financial obligations to foreign countries, accomplishment of a balance is not impossible. Moreover, the Italian, with the new-born confidence, feels sure of the future, even though he realizes and admits that the task is big.

Value of Small Hydro-Electric Plants Shown in Nebraska

State With No Great Concentrations of Water Power Has Developed Many Low-Head Sites on Small Streams

By Albert C. Arend
Consulting Engineer, Omaha, Neb.

THE great importance of the waterpower already in use in Nebraska is not generally comprehended. Nine public utilities now operating in the state, together with some privately owned plants, provide by waterpower for at least a considerable portion of the light and power for every village, town and city located east of the 31st range (the easterly two-thirds of the state), excepting only the municipal plants of Fremont and Hastings and a few small plants operated by steam or Diesel oil engines.

The first waterpower plant in the state was located on the Big Blue River at Beatrice and its rights were provided for by a United States territorial grant in 1860. The second plant on record was built at Milford in 1866. It also was located on the Big Blue River. Since that time many plants have been built in all parts of the state to develop and utilize the most available waterpower. Usually they were for operating flour mills. They used water turbines, steel shafting, gears and belts to produce and transmit the power to the mill machinery as required.

The dams at first were constructed of brush, piling, timbers, stone or masonry, or a combination of these. Probably 20 per cent of these old dams and machinery plants were abandoned because they had become obsolete.

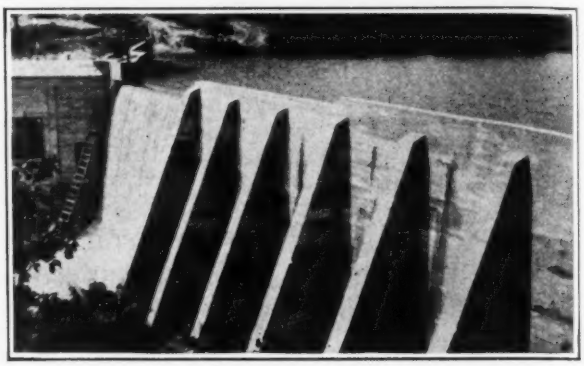
Because of the developments in the use of concrete, many of the old dams were replaced, and all new dams generally have been constructed with that material since about 1907. At that time, because of the developments being made in electric generators and motors and their much greater efficiency for operating the mill machinery, and also because of the growing demand for commercial electric light and power in the local communities, electric generators began to be installed in the old mill plants in order to use their power supply more efficiently and to sell their excess capacity for commercial light and power purposes.

Then, because electric current could be produced locally much more cheaply by waterpower than by steam or other methods, many new waterpower locations were sought out and hydro-electric plants built there for the production of electric current for commercial light and power purposes only. Accordingly the greater number of these plants have been built since 1909, and nearly all of the older plants have been rebuilt or altered so as to produce electric current.

A cursory investigation of the number of such plants which are now evidently operating in the eastern two-thirds of the state shows a surprising total of 79, all ranging in capacity from 40 to 3,000 hp. and with heads of 8 to 54 ft.

The plant at Spencer on the Niobrara is not yet fully completed or operating, and state water appropriations have been granted and plans made for many other feasible sites which have not yet been developed because of the inability of the promoters to finance them.

Very few of these plants are located on the streams of larger flow for there the adjacent markets do not yet require large enough quantities of current for light and power to utilize them fully, and consequently the greater part of the waterpower supply is not yet developed. At least two feasible sites located within economical transmission distance of Omaha have not yet been developed. These were both investigated recently and favorably reported upon by Stone & Webster. One would prdouce about 5,000 hp. from the Platte River at a power house, located near Gretna, and 14,000 hp. from the Platte and Elkhorn rivers combined, using 2,500 sec.-ft. from the Platte and 500 sec.-ft. from the Elkhorn and carrying it about 12 miles by canal to a power house located near South Bend, requiring about



TYPICAL SMALL PLANT, AINSWORTH, NEB.
Developing 150 sec.-ft. at a 30-ft. head.

35 miles of transmission line to Omaha. The other would divert 1,800 sec.-ft. from the Loup River near Genoa and, with a power house near Monroe operating at 51-ft. head, another below Columbus operating at 65-ft. head and a third at Schuyler operating at 80-ft. head, produce a total of 23,000 kw.; this would require about 40 miles of canals and terminate about 60 miles from Omaha, but requiring nearly 100 miles of transmission line from the farthest power house to Omaha.

The only existing waterpower plant within a radius of 66 miles from Omaha is a small one at Ashland.

Because such plants can now be planned to assist materially in the problems of flood control, and can also be operated so that surplus flows can be utilized for irrigation purposes where needed; and because the great value of these features is now beginning to be realized by both farmers and town officials, all undeveloped sites have acquired a new value.

The actual construction costs plus land and overflow damage for six recent hydro-electric developments per kva. of capacity was:

Head	Kva. Capacity	Cost per-Kva. Capacity
17 ft.	240	$417
14 ft.	350	457
18 ft.	900	411
10½ ft.	120	333
15 ft.	500	666
14 ft.	425	351

These plants are all proving satisfactory investments. Some of the costs represent purchase price plus rebuilding, and all of them embrace some unnecessary expense for damages or wasteful plans. It is safe to say that any worthwhile site in the state, of more than 400 kva. capacity, can be properly developed for less than $325 per kva.

Then again there are seven other plants all located on the Big Blue River and built since 1912, which cost

only from $150 to $200 per kva. originally, and look the part. Five of them were put out of commission during one flood in 1923 and require extensive alterations to make them structurally safe, but they have paid anyway.

The lower cost of electric current produced by the small waterpowers of Nebraska has made the price for light and power out in the state definitely lower than it would or could have been otherwise. It amounts to from 20 to 40 per cent in places and equals some of the very low rates in Omaha using the most modern and efficient steam turbine equipment. And these Omaha rates are in turn comparatively lower than in many other large cities.

Arranging Pier Loading Space to Meet Rail and Truck Needs

At Los Angeles Harbor 40 Per Cent of Freight Moves by Rail and 60 Per Cent by Truck—Loading Space Made Convertible

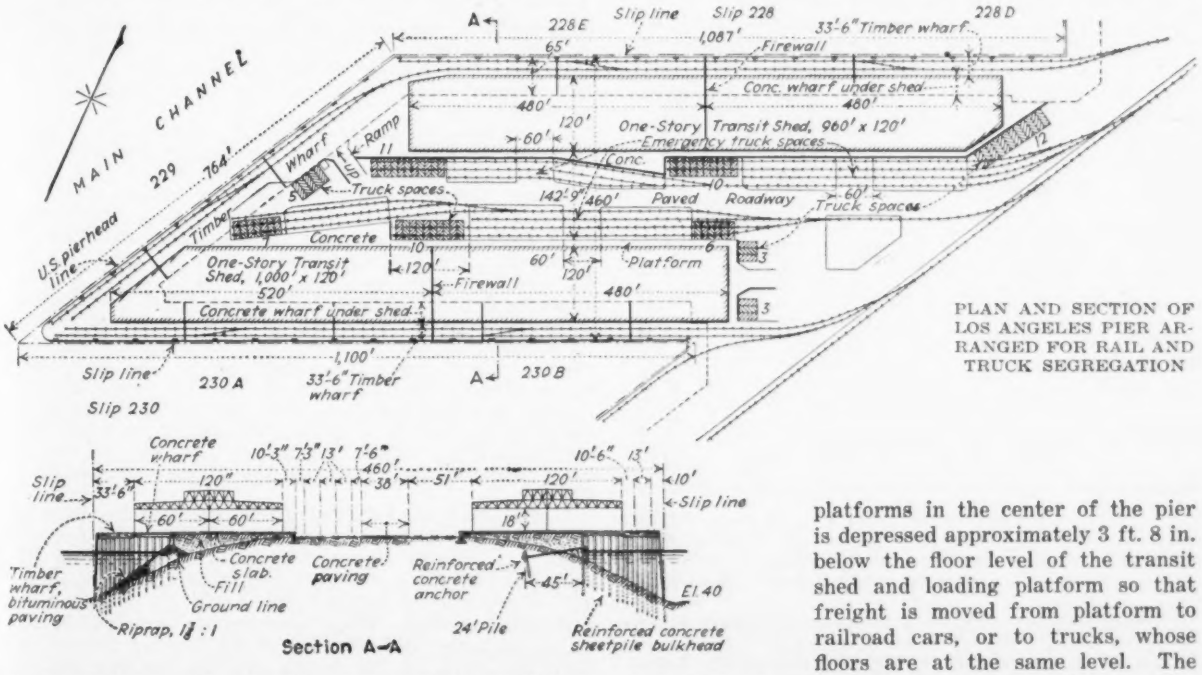
SOMEWHAT unusual arrangement of freight loading space has been found advisable on the municipal piers built for handling general cargo at Los Angeles harbor because only 40 per cent of the freight moving to and from these piers goes by rail, while 60 per cent is handled by motor truck. Under these conditions there were many drawbacks to the usual arrangement of loading space for railway and motor truck freight and in piers recently built an improved layout has been worked out to secure a more efficient arrangement.

The fundamental objection to the usual layout, which was used at Los Angeles until recently, was the interference between rail and truck traffic during the loading process. In the new plan there is a complete segregation, under normal operation, of railroad cars and motor trucks. There are, however, railroad track extensions across some of the space provided for motor trucks and similarly there are emergency motor truck loading spaces within the section intended primarily for loading railroad cars. Thus, in case of a cargo being all loaded to railroad cars or all to motor trucks, the arrangement of the convertible spaces still makes it possible to work to advantage.

Under the old plan a five-berth pier as shown in the accompanying drawing provided trackage for 110 railroad cars, including the use of a third track for storage at the outer berth. That arrangement necessitated a switch crossing to get cars to or from the outer berth when freight was being loaded to or from cars at the inner berth. This crossover took up so much track space at a point about midway between the berths that there was little time when it could be used efficiently because of cars standing on tracks overlapping the crossover.

The new plan provides trackage space for 106 railroad cars, only four less than under the old plan, and gives the advantage of a clear switching track in the center of the pier so that cars may be moved to or from the outer berth without interfering in any way with the inner berth. Also, cars may be switched without interference from individual tracks in the two areas given over to railroad trackage. With this arrangement it is unnecessary to break a string of cars to accommodate motor trucks loading at the motor truck platform.

In the new plan the entire area between the loading platforms in the center of the pier is depressed approximately 3 ft. 8 in. below the floor level of the transit shed and loading platform so that freight is moved from platform to railroad cars, or to trucks, whose floors are at the same level. The whole of the depressed area is paved with the exception of the four areas assigned to railroad cars.



PLAN AND SECTION OF LOS ANGELES PIER ARRANGED FOR RAIL AND TRUCK SEGREGATION

In the new plan the length of the shed on the south side of the pier has been extended to give a more adequate cargo handling space at the outer end. The old plan cut off 125 ft. back from the end of the pier thus depriving the outer berth of a proportionate share of shed room. In the operation of the pier the use of the emergency paved section for trucks is in the hands of the wharfinger stationed at the terminal.

For the foregoing data about the present pier layout, *Engineering News-Record* is indebted to G. F. Nicholson, harbor engineer, city of Los Angeles.

Water Treatment and Other Live Water-Works Topics

Further Abstracts of Papers, Reports and Discussions at Annual Convention of American Water Works Association

(Continued from "Engineering News-Record," June 16)

Studies of Double Coagulation at Cincinnati, Ohio

By C. Bahlman and E. B. Evans
Chief Bacteriologist and Assistant Bacteriologist, respectively, Cincinnati Filtration Plant

DOUBLE coagulation has been used with success at Portsmouth, Ironton and smaller towns in Ohio. At the suggestion of the Ohio State Department of Health it has been tried at Cincinnati. The system used for purifying the Ohio River water at Cincinnati is preliminary sedimentation for 72 hours; coagulation with lime and iron sulphate followed by 5 to 8 hours of sedimentation; mechanical filtration at the rate of 125 m.g.d.; chlorination.

Because of the cheapness of iron sulphate as compared with alum, the use of the former coagulant in the primary reservoirs was worthy of trial. This considerably lessened the load upon the secondary processes, but it soon was apparent that very much better results were obtained by the use of alum than from a dose of iron sulphate of equal cost. Alum was used thereafter. It was applied to the force mains at a point 2,100 ft. from the place where the water is delivered into the primary settling reservoirs. The duration of the experiments varied from 4 to 17 days, not less than 50 m.g.d. being treated. The results obtained while using the primary coagulant were compared with data obtained by single coagulation upon water of comparable nature.

SUMMARIZED COMPARISON OF SINGLE AND DOUBLE COAGULATION

		Single Coagulation	Double Coagulation
Turbidity—	Raw water	470	480
	Effluent primary reservoirs	100	21
	Effluent secondary basins	19	11
20 Deg. Bacteria	—Raw water	30,800	30,800
	Effluent primary reservoirs	5,650	3,360
	Effluent Secondary Basins	860	800
	Filter effluent	96	90
	Chlorinated	27	31
B. Coli per 100 c.c.	—Raw water	5,075	5,145
	Effluent primary reservoirs	820	130
	Effluent secondary basins	175	39
	Filter effluent	8.30	1.54
	Chlorinated	.70	.12
Chemical Doses	—Primary, g.p.g. gr. per gal.	.....	.76
	Secondary, CaO gr. per gal.	.80	.67
	Secondary, FeSO4 gr. per gal.	1.56	1.11
	Chlorine, p.p.m.	.20	.23
Cost of chemicals per m. g.		$2.38	$3.24
Additional cost of double coagulation per m. g		.....	.86
Filter Service	—Hours	27.3	35.8
	Increase due to double coagulation, per cent	....	31.1
Per cent wash water		1.38	1.13
	Saving due to double coagulation, per cent	....	18.1

The accompanying table is a composite of the six experiments in which 1,100 or more B. coli per 100 c.c. were present in the raw water. It will be seen that the deposition of turbidity, 20 deg. C. bacteria and B. coli in the preliminary basins is greatly increased when a primary coagulant is used. The turbidity after primary coagulation is of about the same magnitude as the filter influent in ordinary operation, while the B. coli density is even less than arrives at the filters in single coagulation. The turbidity and B. coli load applied to the filters consequently is very much decreased by the two coagulations; longer filter runs are possible, and the colon content of the filter effluent is greatly improved. The 20 deg. C. counts, except after the primary coagulation, were not benefited to any great extent, however, by the double process.

The decreased loads coming to the secondary processes made it possible, except during the winter, to increase the filter runs by 30 to 65 per cent, thereby saving from 25 to 40 per cent wash water. With ice in the reservoirs, however, no great saving of wash water was possible. The advantages of double coagulation, then, seemed to be confined to the bacterial aspect, since the filter runs, the wash-water demand and the doses of secondary chemicals were little different than in regular operation.

Except under winter conditions, the application of the primary coagulant has always made possible the saving of varying amounts of secondary chemicals. Often the total quantity of the three chemicals used in the double process was less than the total of the two used in single coagulation. With very high raw turbidity this was not the case, although the excess due to practicing double coagulation never was very great.

It seems, then, that for plants using alum as the coagulant, the splitting of this into primary and secondary applications should entail little, if any, additional expense. At Cincinnati, the double process involves additional expense because it was impossible to save enough of the cheaper lime and iron to balance the cost of the more expensive alum used. The maximum additional cost was $1.32, and the average 86c. per m.g. If used, as believed to be advisable, for about 40 per cent of the time, the additional cost at Cincinnati would be $6,500 per annum, equivalent to 36c. per m.g. distributed over the year's output. This additional expense is not prohibitive in view of the many obvious advantages of the double process.

* * *

Developments in Water Softening

By Charles P. Hoover
Chemist, Water Softening and Purification Works, Columbus, Ohio

IMPROVEMENTS have been made in the handling of chemicals and in chemical mixing devices. Dorr clarifiers are being introduced for the removal of settled solids. Methods for further reduction in hardness are being introduced. Zeolite is being substituted for soda-ash to remove non-carbonate hardness. Recarbonization is coming into wider use.

The vacuum system of unloading chemicals from cars and elevating to bins eliminates laborious and objectionable jobs and saves cost through bulk purchases. Dry-feed chemical machines together with lime slakers eliminate chemical solution tanks and their attendant difficulties. Both baffled and mechanical mixing tanks are used at Columbus. The mechanical tanks give no better mixing but are less costly to build than baffled tanks, besides requiring 2 or 3 ft. less operating head, which with proper drive should more than offset the cost of extra water lift. In addition, mechanical mixers are more flexible and accessible. Dorr clarifiers are used in all the municipal water-softening plants built in the last five years. Square as well as round tanks are now equipped with clarifiers [the former with a telescopic adjustment to carry the bottom scraping action into the corners, as was shown by a model in the exhibit at the Chicago convention—Editor].

Limitations in the reduction of hardness have been largely overcome by (1) the hot process, (2) excess lime treatment, (3) split treatment, (4) excess lime followed by carbonization, (5) the use of compounds of alumina, and (6) substitution of zeolite for soda-ash to remove non-carbonate hardness. These processes are explained in detail by the author in *Industrial and Engineering Chemistry*, May, 1927, Vol. 19, No. 5, and only the last one will be discussed in this paper.

Where salt can be obtained at a fair cost it is cheaper to remove non-carbonate hardness by means of zeolite than by means of soda-ash. At Columbus, the discontinuance of the use of soda-ash and the substitution of zeolite equipment is being seriously considered. If adopted, the entire supply of water treated will be softened with lime, coagulated with alum, settled, and carbonated; then a sufficient quantity of it will be softened to zero hardness by zeolite so that by mixing the zero water with the lime-softened water the resultant mixture will have the desired degree of hardness. At the Columbus plant $115,000 is spent annually for soda-ash. It is believed a plant for zeolite treatment can be built for $150,000. The interest on this investment at 5 per cent would amount to $7,500 the first

year but would be less each succeeding year. Retirement charges for 5-years bonds would amount to $30,000 per year and it is estimated that the operation cost would be $75,000, making a total cost of $112,500 per year. This amounts to less than is now being spent annually for soda-ash and if the zeolite plant is installed, it should pay for itself in five years. These cost figures are tentative estimates and must be carefully checked before a decision to change the method of treatment is made.

Lime-softened water is now being cheaply and satisfactorily stabilized by recarbonizing it with carbon dioxide gas at the following water softening plants: Defiance, Newark, Delaware, Piqua, Greenville, Batavia, and Girard, Ohio; Hinsdale, Ill., and Miami, Florida, are also recarbonizing; and plants are being built at Columbus, Ohio, and Springfield, Ill. Plans for a plant are being prepared for the city of St. Louis.

Carbon-dioxide is produced by burning coke, pulverized coal, oil or gas in a suitable furnace. After scrubbing and drying, the carbon dioxide gas is diffused into the water through small openings in a grid system located ahead of the filters.

A carbon dioxide plant should deliver as high a percentage of the gas as controllable combustion will permit. The available fuels from which carbon dioxide can be obtained are coke, which yields about 3 lb. of carbon dioxide from 1 lb. of fuel; artificial gas, which yields about 82 lb. of carbon dioxide from 1,000 cu.ft. burned; natural gas, yielding about 115 lb. per 1,000 cu.ft. burned; kerosene or similar oil, which yields about 20 lb. of carbon dioxide per gallon burned; and producer gas made from coke, yielding about 3 lb. of carbon dioxide for each pound of coke gasified.

In a small plant the fuel expense is practically negligible, and natural gas is really the most suitable fuel because the equipment can be almost entirely automatic. The next most convenient fuel is kerosene or similar oils, which when properly burned in a brick-lined furnace give products of combustion that are tasteless and odorless and in every way suitable for recarbonization of water. The products of combustion from burning these fuels contain about 12 per cent carbon dioxide. The burning of coke in an ordinary furnace or stove produces a gas containing only from 4 to 6 per cent carbon dioxide; therefore, a much larger air compressor must be provided for forcing the gases into the water than where the other named fuels are used.

For large installations producer gas made from coke and then burned to complete conbustion under proper conditions is the most economical method for obtaining carbon dioxide. Such a plant is now being built at the Columbus water softening and purification works. The gas-making plant will consist of six principal parts: a gas producer (coke), a gas burner, a return tubular boiler, a steam-driven air compressor, a combination scrubber and drier, and a diffuser.

The carbon dioxide gas converts the normal carbonates, which are only slightly soluble, to bi-carbonates, which are highly soluble, and will therefore not be easily precipitated from the water. At all the water-softening plants now operating re-carbonizers, just enough carbon dioxide is added so that the carbonated water shows a slight trace of color when phenolphthalein is added. The carbonated water should have a pH of from 8 to 8.5. Recarbonization should not increase the corrosive properties of water.

* * *

Other Papers and Discussions

Service Connections and Goosenecks: Emil Nuebling, Chief Engineer, Water Bureau, Reading, Pa.—Copper or brass is the most satisfactory material for smaller water services, with lead as an alternate material, while cast iron proves the best for services 2 in. in size and larger. For goosenecks, copper or lead may be used equally well in the smaller services but no gooseneck should be used for 2-in. or larger services. Tin-lined wrought iron is placed third in the smaller services and second in the larger services.

Grounding Electric Circuits on Pipes: E. E. Minor, General Manager, New Haven (Conn.) Water Co.—A revision of the National Electrical Code with respect to the grounding of electrical circuit is planned by the American Committee on Electrolysis, of which the author is a member. The increased tendency to use a non-metallic joint in water mains as well as the continued use of pipe lines of non-metallic material is creating a condition which is hazardous to life and property. Grounding connections made on services should in any case be ahead of the meter, permitting the meter to be taken out without interrupting the electric circuit. Where this is impracticable, a metallic connection should be provided around the meter. The adoption of the multi-grounded common neutral conductor system in a number of cities has created a serious condition.

Well Capacity: W. G. Kirchoffer, Consulting Engineer, Madison, Wis.—To determine the capacity of wells in sand or gravel formations the fineness modulus rather than the effective size of the sand may be used. The fineness modulus is determined as in the analysis of fine aggregate for concrete and the capacity of flow is deduced from this figure. A fineness modulus of 300 or over is taken to represent a good yield while one of 100 or 150 would represent a poor yield.

Well Water Recessions—An entire session was devoted to well supplies in which the lowering of the ground-water level and the conditions affecting this occurrence were considered. Papers were presented dealing with conditions in northern Illinois, Iowa, Wisconsin and Indiana. Slight lowering of the ground-water level was reported in Indiana, while in Wisconsin among the deep wells the recession has averaged 1 ft. a year for the past 28 years. This is attributed to leakage, deposits in the rock pores near the wells, and a decrease in the general static head of the artesian belt. Lowering of the ground-water level, generally, was mentioned as being due to the use of farm tiling and the dredging and construction of drainage ditches.

Consumers' Billing and Accounting Machines: D. C. Groebel, assistant secretary, Water Board, Detroit, Mich.—Eight billing machines handle all the bills of 233,000 metered consumers, an increase of 70 per cent of billing work is done without any increase in the force, and neater results were obtained than by the hand system.

Industrial Development and Water Quality—Ingenious unfolding colored diagrams were used by W. D. Collins, U. S. Geological Survey, to contrast some of the leading water supplies of the country as regards hardness and the qualities affecting their industrial use. Relative growths of various industries in parts of the country having water supplies well and properly suited for manufacturing purposes were presented by means of shaded maps. Stress was laid on the slow progress of water softening for municipal supplies.

Sodium Aluminate Combined with Alum—Data on the use of sodium aluminate used with sulphate of alumina as a coagulant were presented by C. A. Christman, Chicago Chemical Co. A small dosage of sodium aluminate saves alum and eliminates residual alum, lowers the carbon dioxide content of the located water and helps maintain an optimum pH. The combination is in use in a number of plants.

Phenol Wastes—A symposium on the control of tastes and odors caused by phenol wastes indicated encouraging progress, especially in the Ohio River Basin where the industries are co-operating with a board of engineers representing mine states; chairman, W. L. Stevenson, engineer, Pennsylvania Board of Health, Harrisburg.

Chlorination—There was an extended discussion on pre-, post- and super-chlorination, dechlorination, and chlorination for algal content. A lantern slide talk on "The Story of Chlorine" was given by L. H. Enslow, sanitary engineer. The Chlorine Institute, New York City, in the absence of Robert T. Baldwin. It was devoted chiefly to the saving and convenience of buying chlorine in one-ton instead of 150-lb. containers.

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Least Error in V-Notch Weir Measurements When Angle Is 90 Degrees

By Morrough P. O'Brien
Engineering Experiment Station, Purdue University, Lafayette, Ind.

A MATHEMATICAL proof that a 90-deg. V-notch will give the least error in computing the discharge over triangular weirs is given below.

An error in determining the angle introduces an error in the computed discharge and this error depends upon the precision of the measuring instrument. During some recent tests on triangular weirs at Purdue University, individual measurements of the angle showed an extreme range of 20 min. with a probable error of ± 3 min. in the mean of six observations. Furthermore there was a 7-min. difference between the means of two series of readings taken before and after the weir plate was bolted to the weir bulkhead. The plate was found to be swung downstream ⅛ in. at the top of the sides of the notch.

In taking a series of measurements, the probable error is computed by dividing the average divergence from the mean by the square root of the number of observations. This value may then be used to obtain the probable error in the computed discharge. Using the Gourley and Crimp formula where Q is the discharge in second-feet, H is the head in feet and θ is the notch angle, and letting ΔQ represent the error in the computed discharge resulting from a small error in the angle, then

$$\text{Per cent error} = \frac{\Delta Q}{Q}\,100 = \frac{Q_R - Q_T}{Q_T}\,100$$

$$= \left[\tan\left(\frac{\theta}{2}\right)_R - \tan\left(\frac{\theta}{2}\right)_T\right]^T \frac{100}{\tan\left(\frac{\theta}{2}\right)_T}$$

in which the subscript R refers to the mean value plus or minus the probable error and the subscript T refers to the mean value. Providing the same instruments and the same number of observations are made, the probable error will be the same regardless of the value of θ. The following table shows the per cent of error in computed discharge caused by errors in measurement of the V-notch angle in the Gourley and Crimp formula, using a probable error of +10:

θ_T	$\tan\left(\frac{\theta}{2}\right)_T$	θ_R	$\tan\left(\frac{\theta}{2}\right)_R$	$\tan\left(\frac{\theta}{2}\right)$	% Error
10°	.0875	10° - 10′	.0889	.0014	1.60
30°	.2679	30° - 10′	.2695	.0016	.595
60°	.5774	60° - 10′	.5793	.0019	.329
90°	1.0000	90° - 10′	1.0029	.0029	.290
120°	1.7321	120° - 10′	1.7379	.0058	.335
170°	11.430	170° - 10′	11.625	.1950	1.705

where R refers to the observed and T to the true angle.

Differentiating Q with respect to θ in the Gourley and Crimp formula, it is shown that the probable error should be a minimum for a 90-deg. notch. The complete derivation is as follows:

$$dQ = \frac{K}{2}\sec^2\frac{\theta}{2}\,d\theta$$

where $K = H^{2.47}$ = constant and this may be written without errors of any consequence

$$\Delta Q = \frac{K}{2}\sec^2\frac{\theta}{2}\,\Delta\theta$$

where $\Delta\theta$ is a constant. In above table it is equal to 10 min. The percentage of error is then

$$E = \frac{\Delta Q}{Q}\,100 = 100\,\frac{\Delta\theta}{2}\,\frac{\sec^2\frac{\theta}{2}}{\tan\frac{\theta}{2}}$$

Differentiating this with respect to θ and writing $100\,\frac{\Delta\theta}{2} = C$, we have

$$\frac{dE}{d\theta} = C\left[\frac{2\tan^2\frac{\theta}{2}\sec^2\frac{\theta}{2} - \sec^4\frac{\theta}{2}}{\tan^2\frac{\theta}{2}}\right]$$

$$= C\,.\,\operatorname{cosec}^2\frac{\theta}{2}\left[2\tan^2\frac{\theta}{2} - \sec^2\frac{\theta}{2}\right]$$

For E to be a minimum, $\frac{dE}{d\theta} = 0$ so that

$$2\tan^2\frac{\theta}{2} - \sec^2\frac{\theta}{2} = 0$$

$$2\tan^2\frac{\theta}{2} = \sec^2\frac{\theta}{2}$$

$$\theta = 90°$$

Dam Wickets Thawed by Steam

By F. Y. Parker
Associate Engineer, U. S. Engineer Office, Kansas City, Mo.

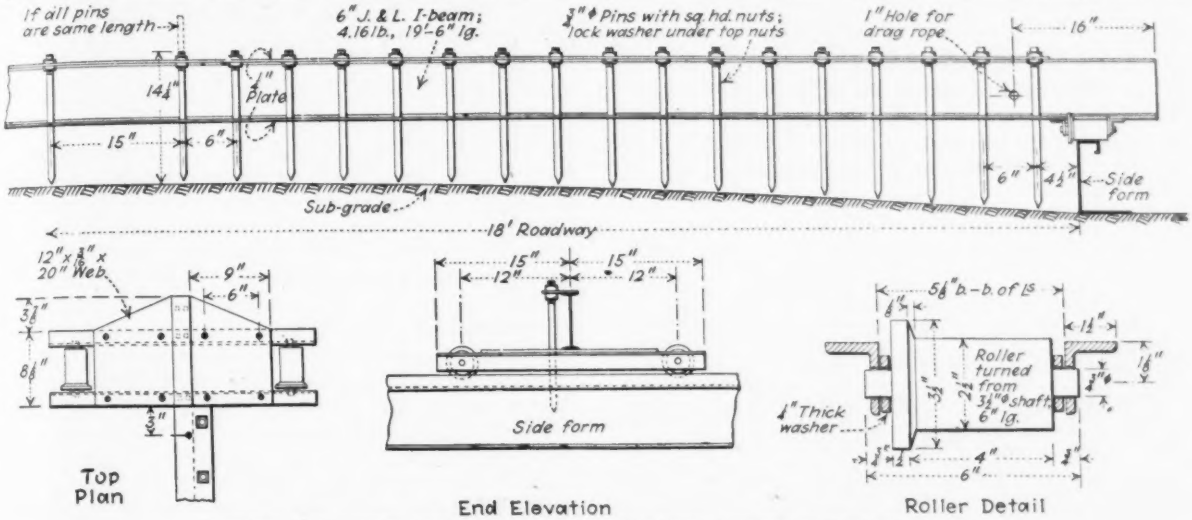
THE government lock and dam (Osage River, mile 7, above the mouth), comprise the lock chamber; five drum weirs and a 415-ft. navigation pass which can be closed by 100 wickets. A sudden cold snap in January resulted in the conditions depicted in the photograph. It was deemed advisable to thaw out and lower the wickets. The pool was emptied by lowering the drum weirs. The maneuvering barge was manipulated to the apron and steam was played against the sheathed ice, the large projections being first knocked off with an axe.

WORKMEN THAWING WICKETS ON OSAGE LOCK AND DAM

As the timber apron is inclined the workers were forced to wade in about a foot of water while removing the ice.

All-Steel Subgrade Tester for Pennsylvania Roads

THE increasing accuracy of subgrade profile demanded for paved roads has quite generally called into use templets for checking the graders' workmanship. One of the latest designs to be adopted as a standard for state road work is shown by the accompanying drawing. It is standard in Pennsylvania. The highway department will not insist on this exact design, but any other shall be submitted for approval and the general features shall conform to those in the drawing; that is, the size of and the difference between pins, the weight, the stiffness and the distance between rollers which will bear upon the forms. For varying widths of roadway, the weight of the subgrade tester shall be not less than 22 lb. per foot of width. The standard was issued under W. H. Connell, former engineering executive and deputy secretary of highways, Pennsylvania.



STANDARD SUBGRADE TESTER PENNSYLVANIA HIGHWAY DEPARTMENT

Structural Details of Erecting Large Advertising Sign

By Elwyn E. Seelye
Consulting Engineer, 101 Park Ave., New York City

A SIGN recently built at Lido Beach, Long Island, is of interest because of the methods used in design and construction. The top of the letters of this sign are 60 ft. from the ground, the height of the letters 50 ft., the width of their stroke from 10 to 12 ft. and the sign itself is 600 ft. long.

This sign was supported on 55-ft. oak poles spliced out to a length approximately 65 ft., between which were stretched a gridiron of ½-in. galvanized steel cables. Occasionally diagonal cables were used in the plane of this gridiron to support vertical loads occurring between the poles. These cables were drawn sufficiently taut to eliminate nearly all sag. As there was to be considerable stress in these cables heavy anchorages were provided at the end poles. These anchorages consisted in 12x12 timbers 18 ft. long underneath a plank gridiron buried approximately 8 ft. in the ground. In addition to this ample lateral support for the poles was provided by cables extending to anchorages 75 ft. away from the sign at the front and rear. The body of the letters was made up of 24-gage galvanized iron nailed to wooden frames. The end anchorages were connected to cables by means of equalizing plates. The letters were perforated to reduce wind pressure.

Poles were erected by a tractor crane and were placed on concrete foundations set in the ground about 3 ft. These concrete bases for the poles were about 3x3 ft. in size.

The total cost of the supporting framework of this tower including contractor's profit was less than $10,000. The contractor and designer was W. Michelson, 50 Church St., New York City. The structural details were worked out by the writer.

REAL ESTATE SIGN COMPLETED AT LONG ISLAND BEACH
Note perforations to reduce wind pressure. Supporting frame invisible at distance of half mile.

Tables Give Pipe Line Data for Road Water Supply

WATER supply for concrete road work in Pennsylvania will require pipe sizes as determined from Tables I and II. The tables are based on a requirement of 8,000 gal. of water for 100 ft. of paving apportioned as follows: One-half for curing, one-quarter for subgrade, one-quarter for the mixer. The pavement is assumed to be 18 ft. wide. The head given is based on friction loss only. To this must be added the height of the outlet of the pipe above the source of supply.

The internal diameters are for 2-in. pipe 2.067 in.; for 2½-in. pipe 2.469 in., and for 3-in. pipe 3.068 in. The formula used is the Hazen-Williams as follows:

$$H = K \frac{lv^{1.87}}{d^{1.165}} \text{ in which}$$

H = loss of head due to friction;
K = 0.00038;
l = length of pipe in feet;
v = velocity of water in feet per second;
d = diameter of pipe in feet.

TABLE I—LOSS OF HEAD DUE TO FRICTION IN STEEL PIPES FOR WATER USED IN PAVING

Feet Per Hr.	Gal. Water Per Hr.	Vel. Ft. Per Sec.	Length of Pipe ½ Mi.	1 Mi.	1½ Mi.	2 Mi.	2½ Mi.	3 Mi.
					2-in. Pipe			
50	4,000	6.37	288	577	866	1,155	1,444	1,732
60	4,800	7.65	406	812	1,218	1,624	2,030	2,436
70	5,600	8.92	542	1,083	1,625	2,167	2,708	3,250
80	6,400	10.20	695	1,391	2,086	2,781	3,477	4,172
90	7,200	11.47	867	1,733	2,600	3,466	4,333	5,200
100	8,000	12.75	1,055	2,111	3,166	4,221	5,277	6,332
					2½-in. Pipe			
50	4,000	4.47	119	238	357	476	595	714
60	4,800	5.36	167	335	502	669	836	1,004
70	5,600	6.25	223	446	669	893	1,116	1,339
80	6,400	7.15	286	573	859	1,146	1,432	1,719
90	7,200	8.04	357	714	1,071	1,428	1,785	2,142
100	8,000	8.93	435	870	1,304	1,739	2,174	2,609
					3-in. Pipe			
50	4,000	2.89	40	80	121	161	201	241
60	4,800	3.47	57	113	170	226	283	339
70	5,600	4.05	75	151	226	302	377	453
80	6,400	4.63	97	194	291	388	485	581
90	7,200	5.21	121	242	362	483	604	725
100	8,000	5.79	147	294	441	588	736	882

These tables may be used to compute length of pipe, size of pipe or required horsepower and pressure.

For example, to determine size of pipe the procedure is: Estimated progress of paving, 70 ft. per hour; maximum water pressure in pump, 500 lb. per sq.in.; maximum distance water must be forced, 2½ miles.

TABLE II—HEAD-PRESSURE AND PRESSURE-HEAD CONVERSION TABLES

Head Ft.	Pressure Per Sq.In.	Head Ft.	Pressure Per Sq.In.	Pressure Per Sq.In.	Head Ft.	Pressure Per Sq.In.	Head Ft.
10	4	200	67	4	9.2	50	115
20	9	300	130	5	11.5	60	138
30	13	400	174	6	13.8	70	161
40	17	500	217	7	16.1	80	184
50	22	600	260	8	18.4	90	207
60	26	700	304	9	20.7	100	230
70	30	800	347	10	23	200	461
80	35	900	391	20	46	300	691
90	39	1000	434	30	69	400	922
100	43	2000	868	40	92	500	1152

What size pipe is required? 500 lb. = total water pressure available, which corresponds to 1,152 ft. head; 2-in. pipe under these conditions requires 2,708 ft. head or 1,175 lb. pressure and is too small. Two and one-half-inch pipe is necessary and requires 1,116 ft. head, which corresponds to 484 lb. pressure. A 3-in. pipe requires 377 ft. head which corresponds to 163 lb. pump pressure.

From Job and Office

Hints That Cut Cost and Time

Importance of Checking Engineering Drawings and Computations

BY J. W. JOURDAN
Designing Engineer, San Joaquin Light & Power Corp., Fresno, Calif.

AN ENGINEERING drawing, computation or operation, no matter by whom or how well it may have been executed, is not above the suspicion of error until after it has been intelligently checked by a competent person. Adverb, adjective and noun are used advisedly. It is not sufficient to require that an engineering operation shall be *checked*. It must be checked by another person. The checker must be *competent* and the work of checking must be done *intelligently*.

Only in an emergency should the checking be done by the person who performed the work. An engineer sent to inspect a project may render a report based on measurements and calculations that no one at the time except himself is competent to check. In this and similar cases, the engineer must check his own work. Then it would be well to follow a few simple rules and practices to insure final accuracy of operation, statement and result.

Using my own experience, the following suggested list of rules has been prepared. It is assumed at the start that the problem in hand has been carefully analyzed and that it has been solved and is ready to check. The list, which may be changed to suit various conditions, is as follows:

(1) Check the problem by rough calculation either mentally or on paper; (2) look at the problem from a changed point of view, if possible, and in a changed sequence of operations; (3) check the answers to the several parts as well as the final answer by the use of ratios and proportions; (4) question the reasonableness of methods employed and the results obtained by using all the engineering training, observation and experience at your command; (5) try to find flaws in your reasoning and in your results and overcome the danger of bias by putting yourself in place of the second party; (6) let your problem rest for a space of time, a week if possible, and then look at it with a refreshed mind.

The process of self-checking at best is defective and is to be avoided in practice for a final check. However, the engineer may profitably apply the foregoing rules to his problem in any case before turning it over to a competent person for final checking.

A competent person, as referred to here, implies a person who is more than merely capable. A capable young engineer may check computations, formula for formula, and figure for figure, and he may discover mistakes and correct the answer, yet the result may be absolutely in error. If the checker is not competent to check the fundamentals and analyze the problem as a whole, his efforts may be quite valueless. Engineering work of a complex character should therefore be checked in its broader aspects by a well trained and competent engineer with broad experience. The details may then safely be checked by a capable person who is conscientious and not mentally lazy.

From Job and Office

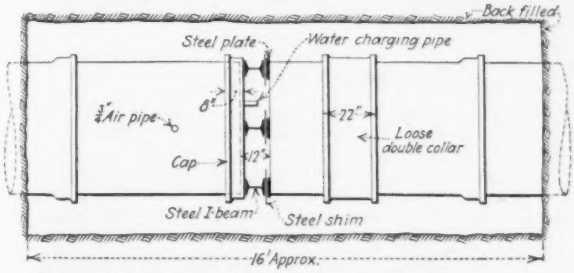
For Contractor and Engineer

Leakage Test of 48-In. Cast-Iron Water Main in England

BY T. F. YOUNG
Westminster, England

IN *Engineering News-Record* of Nov. 26, 1925, p. 870, there appeared an article on the methods used and results obtained in testing lead-jointed cast-iron force mains in the water-works of Columbus, Ohio. Inclosed is a sketch showing one method in use in England for strutting the cap during test. Other methods are in use, but to date this has proven the most satisfactory and for the following reasons: (1) The closure pipe, the collar and the cap can all be placed and the joints run by the pipe-laying gang as normal work. (2) On completion of the tests, the cap joints are burned out and the double collar slipped into place, the joints run, calked and ¾-in hole plugged and the hole backfilled. (3) The whole of the strutting being steel, the tendency for the joints to draw water under test (due to compression of the strutting rig) is eliminated. (4) Less chance of breaking the cast-iron cap, as it is supported at six points.

On the contract where this rig was used, the test con-



METHOD OF HOLDING CAP FOR TESTING A 48-IN. WATER MAIN IN ENGLAND

ditions were more severe than those at Columbus, Ohio, described in the article mentioned. The contract here required each individual joint to be tested to a pressure of 260 lb. per sq.in. before being backfilled. This was accomplished by means of a special testing machine traveling inside the pipe and testing all joints as made.

On completion of definite lengths (which varied) the pipes and the joints were required to withstand a head of water test to a pressure varying from 140 to 200 lb. per sq.in., the pressure to be maintained for not less than 30 minutes, and with a maximum loss of 50 gal. per mile per hour of main under test. The pipes were of cast iron, nominally 12 ft. long, of 48 in. internal diameter, and weighed aproximately 10,000 lb. The joints are leaded and were calked by hand. The main was charged with water at about 50 lb. pressure from an existing pressure main alongside. Pressure was then raised by means of a gasoline-driven force pump and maintained by means of a hand pump taking water from a calibrated vessel.

The results obtained on a certain test length are shown by the accompaying table.

LEAKAGE TEST OF 48-IN. CAST-IRON WATER MAIN

Length, Ft.	Duration of Test, Min.	Gallons of Water Used Total	Per Mile per Hour	Pressure, Lb.	Remarks
1,629	30	7	45	130	Concrete bulkhead at commencement tilted. Test abandoned.
3,246	50	Nil	Nil	100	Same section
3,246	37	Nil	Nil	200	
2,820	246	83	38	140	
558	70	3½	28	170	
1,536	126	10	17	170	
2,124	47	10	32	170	
5,247	48	27	34	170	Same section
5,247	10	Nil	Nil	140	
2,094	60	23	58	170	Same section
2,094	10	Nil	Nil	140	

Welded Residence Construction

IN THE past year a number of residences with welded steel frames have been erected in the metropolitan area of New York City. Most of these have been de-

FIG. 1—RAISING BASEMENT PANEL OF CAST CONCRETE IN WELDED STEEL FRAME

signed similarly to wood frame houses. In one of the accompanying illustrations workmen are shown raising the basement panel for a two-story welded steel residence in Teaneck, N. J., erected by the Electric Arc Cutting and Welding Co. and the Weldcrete Co., both of Newark, N. J. These basement panels were made of welded steel rectangles using ⅜x4-in. flats in which the concrete slab was cast while the panel was lying on the

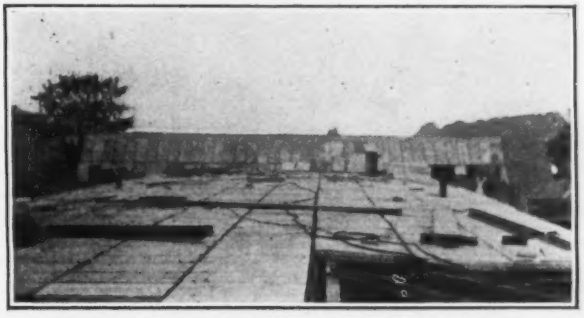


FIG. 2—T-BAR PURLINS WELDED TO RAFTERS FOR FLAT-SLAB ROOF CONSTRUCTION

ground. Each successive floor was erected in the same way, panels being raised to position and welded into place. Window and door frames were also welded.

A practice being used on buildings using slab roofs is the welding of the T-section purlins to the rafters. By using this method the roof framing is erected very rapidly.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Steel-Slab Column Bases

Sir—I have read with much interest Mr. Fleming's timely article in your issue of June 7 on "Proportioning Steel Slabs for Column Bases."

In referring to an article in *Engineering News-Record* of April 27, 1922, in which I advocated the use of multiple steel slabs for large column bases, giving as an example a design having three layers of slabs supporting a column load of 3,400 tons, he says: "However, Mr. Stern's method is not practicable. The slabs are the first steel material wanted and when of unusual size they can be procured, if at all, only with considerable delay. Such would be the case with his 82 x 82 x 5½-in. slab." An as actual fact, there was no delay whatever in obtaining these large slabs promptly. They were furnished quickly by the Lukens Steel Co. and finished by Levering & Garrigues, who were contractors for the structural steel.

As regards the computations, Professor Talbot's method in designing reinforced-concrete footings based on experiments seems reasonable if applied to any elastic material, and ought to give rational results applied to steel slabs. However, the mathematicians of today have not given us a workable formula, due probably to the fact mentioned by Mr. Fleming, that the problem is not adapted to direct

THREE-LAYER SLAB BASE OF HEAVY COLUMN

practical solution, and I agree with him that tests ought to be made to derive some workable formula.

The use of steel slabs is growing very rapidly. Their advantage over all other types of column base is borne out by the experience of those familiar with the older designs. In the case I have mentioned above (see illustration), a base to support the same load of 3,400 tons made up of girders and grillage beams would have required a depth of about 7 ft. as against 22 in. for the three layers of slabs. The additional rock excavation and concrete filling would have added several hundred dollars to the foundation cost, the cost of steel in both designs being the same.

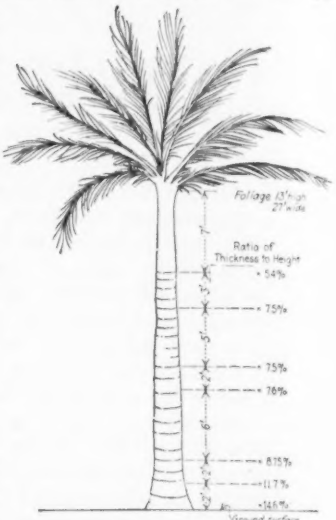
New York City, June 13, 1927.

EUGENE W. STERN, Consulting Engineer.

Nature as a Column Builder

Sir—Here in Florida, under semi-tropical conditions, flourish various kinds of palms. The one called the Royal Palm is unquestionably the most ornamental tree to be found here. This palm is regular in its growth, stands firmly erect, and is formed by nature so that it easily resists heavy wind stresses.

The attached sketch is a Royal Palm drawn to scale, showing ratio of thickness of trunk to height. This may be of interest as showing how nature solves the problem of proportioning a column, anchored at the base, unsupported at the top, and resisting wind pressure, applied at the top of the column.



ROYAL PALM — SHOWING COLUMN PROPORTIONS

The anchorage consists of thousands of small roots. This particular palm has a woody trunk 20 ft. high, 35 in. in diameter at the base and 18 in. in diameter throughout most of its height above the base. The foliage spreads 27 ft. wide and 13 ft. high, and the base of the foliage is 7 ft. above the top of the woody trunk.

CROSBY TAPPAN, Engineer, Mizner Development Corporation.

Boca Raton, Fla., May 15, 1927.

Irrigation and the Future

Sir—I have read with much interest and gratification the editorial "Irrigation and the Future" in your issue of June 2. My first thought in reading it is that it is regrettable that a similar editorial could not have been, and was not, written twenty years ago. The task of re-orienting people's minds on that phase of irrigation with which the editorial is specially concerned is a large and important one. It involves, among other things, a complete reversal of opinion regarding quantitative relationships between irrigation water, on the one hand, and the conservation of irrigation land on the other.

Your editorial is a statesmanlike exposition of a situation that seems certain to be of increasing national importance.

F. D. FARRELL, President, Kansas State Agricultural College.

Manhattan, Kan., June 10, 1927.

Canada Gains in Developed Water Power

At the end of 1926 the Dominion of Canada had an installed capacity of 4,556,266 hp. in its water power plants. This was an increase of 265,838 hp. over the previous year, according to the Canadian Department of the Interior. On the basis of 24 hour power at 80 per cent efficiency, the known available water power in Canada amounts to 18,255,000 hp. for conditions of ordinary minimum flow and 32,076,000 hp. ordinarily available for six months of the year. Using present installations as a criterion, these totals indicate that the ultimate installed horsepower in Canada should exceed 41,700,000. The province of Quebec leads with an installed capacity of 1,915,443 hp. and the province of Ontario is second with 1,790,588 hp. These figures are almost equal to the installed horsepower in the two leading states in the United States, California with 1,922,000 and New York with 1,758,000.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Spring Valley Water Co. Purchase Voted Down

The proposal to issue $40,000,000 of bonds by the city of San Francisco for the purchase and extension of the works of the Spring Valley Water Co. was defeated at a special election held June 14, despite a large actual majority. A $4,700,000 bond issue for extensions of the municipal railway system into residential districts also was defeated. The necessary two-thirds majority was recorded for war memorial bonds ($4,000,000) and for completing the Bernal cut ($1,400,000). A charter amendment relating to garbage collection through licensed scavengers, requiring only a plurality of votes, was carried, as noted in detail separately. The votes on the four bond issues, as given the morning after the election by the San Francisco *Chronicle* were:

	Spring Valley Purchase	Municipal Ry. Ext.	War Memorial	Completing Bernal Cut
Yes.....	41,488	44,305	48,771	52,224
No.....	28,799	25,888	20,893	18,391
Actual Majority.	12,689	18,417	27,878	33,833
Total Votes	70,287	70,193	69,646	70,615

The total number of ballots cast was 73,177, which was less than a third of the number of registered voters.

This was the fourth defeat of purchase of the property of the Spring Valley Water Co., but at each of the three earlier elections, as at this, there was an actual majority of votes for purchase. The figures, according to the *Chronicle* were: Jan. 14, 1910, 22,068 to 11,722; April 20, 1915, 39,951 to 33,455; March 8, 1921, 43,073 to 30,922.

Nebraska Proposes Public Toll Bridges

Interstate bridges over the Missouri River, with temporary tolls to refund the bonds, are provided for in a bill passed at the last session of the state legislature of Nebraska. This bill authorizes the State Department of Public Works to act for Nebraska in cooperation with other states and the federal government in the construction of interstate bridges, but it provides that no state funds shall be used and not to exceed $50,000 per year of federal funds. The idea back of the law is that local subdivisions, counties and cities would vote bonds to represent one-fourth of the total cost, using another fourth of federal-aid from the state, and operating the structure as a toll bridge until sufficient money had been collected to reimburse that part paid from local funds. As yet no adjacent state has passed any legislation along this line, and nothing will be done until it is possible for Iowa, Missouri and South Dakota to co-operate with Nebraska in this bridge work.

John M. Goodell Dies

Former Editor of "Engineering Record" and Prominent in Water-Works and Highway Fields

John M. Goodell, former editor of *Enginering Record* and an associate editor of *Engineering News*, and a noted figure in the highway and water-works fields, died in New York City June 21, at the age of 60 years.

Mr. Goodell was born in Worcester, Mass., Aug. 3, 1867, and was educated at Worcester Polytechnic Institute, being graduated from that institution in 1888 with the degree of bachelor of science in civil engineering. Two years later he joined the editorial staff of *Engineering News* as an associate of Arthur M. Wellington, leaving two years later to become an associate editor on *Engineering Record*. After two years with that publication he was made assistant secretary of the American Society of Civil Engineers, but left that position in 1897 to return to *Engineering Record*.

After five years of editorial work Mr. Goodell joined the staff of Joseph H. Wallace, engineers, as a resident engineer on paper-mill construction at Sault Ste. Marie. He stayed there but a year and in 1903 returned again to *Engineering Record*, this time as editor. He retired from that paper in 1912 and E. J. Mehren, vice-president of the McGraw-Hill Publishing Co., Inc., was made its editor.

Various affairs then occupied Mr. Goodell until his death. He first collaborated with Metcalf and Eddy in producing their three-volume work on "American Sewerage Practice." He was next associated with L. C. Wason, president of the Aberthaw Construction Co., in the reorganization of the American Concrete Institute. Prior to the World War Mr. Goodell was engaged in highway organization work and prominently identified with the American Highway Association, which he helped to establish. During the war he was employment manager, first for the production division and then for the entire Emergency Fleet Corporation. During the last months of the war he was acting chairman of the National Highway Council which had charge of materials, transportation and labor for road work. Shortly after that for a time he was consulting engineer to the Bureau of Public Roads, concerned chiefly with organization work. Latterly he had been in charge of publicity and advertising for Babcock and Wilcox, New York City, and he had been editor of the *Journal* of the American Waterworks Association.

He was an affiliate of the American Society of Civil Engineers, a member of the American Society of Mechanical Engineers, the American Water Works Association and of the New England Water Works Association. He was the author of "Water Works for Small Cities and Towns," "Location, Construction and Maintenance of Roads" and translator of Baumeister's "Cleaning and Sewerage of Cities."

Wanaque Aqueduct Controversy To Be Umpired

By request of representatives of the contracting municipalities, the North Jersey District Water Supply Commission, on June 16, agreed to refer the controversy over a change from concrete to steel for the Wanaque aqueduct and various related matters, noted in several previous issues of *Engineering News-Record*, to a consulting engineer. Four names were submitted to the commission by the municipalities: Allen Hazen, New York; John R. Freeman, Providence; Harrison P. Eddy and Frank Winsor, Boston. The commission agreed to confer with Mr. Freeman as to willingness to undertake the work, time required and price.

Agreement Reached in Oregon Railway Plans

The Oregon Trunk Ry. and the Southern Pacific Ry. have reached an agreement in regard to proposed new railway lines in Oregon whereby the Oregon Trunk will be granted operating rights over the Southern Pacific tracks from Paunina to Klamath Falls. This matter has been under discussion for many months. Failure to reach an agreement after many conferences between the officials of the two railways resulted in an order of the Interstate Commerce Commission (*Engineering News-Record*, May 26, 1927, p. 879) authorizing the Oregon Trunk Ry. to build from Bend to Klamath Falls, a distance of about 160 miles. The present agreement, made since this latter order was issued, reduces the amount of new construction to about 40 miles, a short-line railroad along the proposed route having been purchased some time ago.

Los Angeles Aqueduct Dynamited for Fourth Time

Another dynamiting (the fourth in less than a month) of the Los Angeles aqueduct occurred early June 19 near Diaz Lake, two miles south of Lone Pine in Owen's Valley. A small section of the open concrete-lined aqueduct was torn out by the blast.

The latest dynamiting follows a series of attempts on the part of merchants and tradespeople in Owens Valley towns to negotiate a settlement with the Los Angeles Water and Power Commission for the loss of business since Los Angeles purchased orchard and farming land in the valley to acquire water rights for the municipal supply.

Details of three previous dynamitings were contained in *Engineering News-Record*, June 9, p. 960.

Montreal Typhoid Cases Pass 4,600 in Fifteenth Week

In the fifteenth week (June 10-16) of the Montreal typhoid epidemic, 92 cases were reported, or an average of 13 a day. New cases on June 16 were only 9, but the following day the number rose to 13, and during Saturday, June 18, there were 15 cases reported, making a total of 4,633 for 15 weeks and two days. Typhoid deaths from Jan. 1 to June 17 totalled 431, of which 15 occurred from Jan. 1 to March 12, the latter being the tenth day of the epidemic. By weeks, the first crest of the epidemic was the fourth week, ending March 31, with 658 cases. A second and higher crest occurred in the eleventh week, with 727 cases for the week ending May 19.

The United States Public Health Service, with permission of the Canadian authorities, has sent an investigating board of four members to Montreal to make an intensive survey of the situation and to submit recommendations to prevent the spread of typhoid into the United States. The members of the board are Surgeons L. L. Lumsden (chairman), J. P. Leake and C. E. Waller and Sanitary Engineer H. R. Crohurst.

Lawson Appointed to Boundary Commission

L. M. Lawson, superintendent of the Yuma project of the Bureau of Reclamation, has been appointed as a member of the American Section of the International Boundary Commission between the United States and Mexico. The appointment was made with a view to bringing to that important post an engineer thoroughly informed on boundary problems.

There is great need for an agreement on a fixed boundary between the United States and Mexico because of the tendency of the Rio Grande, which forms the boundary, to change its course. Such occurrences result in the sudden transfer of land from the American side of the river to the Mexican side and vice versa, and numerous difficulties arise therefrom.

Mr. Lawson has been given a leave of absence from his position as superintendent of the Rio Grande project in order to enable him to serve as commissioner. However, he will continue to make his headquarters in El Paso and will be available for advice in connection with the project.

Mr. Lawson, born in 1879 at Washington, is the son of Col. Gaines Lawson of the U. S. Army. He graduated at Leland Stanford University and subsequently served on the San Francisco water supply and on the U. S. Geological Survey in western survey work. In 1905 he became assistant engineer on the Yuma project of the Reclamation Service, and subsequently occupied various positions in the service, being in charge of levee construction on the Colorado River, assistant to supervising engineer of the southern district, engineer of the Rio Grande and Yuma projects, and for the past 10 years manager and superintendent of the Rio Grande project.

Boston & Maine Engineering Department Reorganized

Engineering, Construction, Valuation, Maintenance and Signals Now Under Single Engineer

The engineering department of the Boston & Maine Railroad Co. was reorganized on Apr. 1, the former departments of engineering, construction, valuation, maintenance-of-way, and signals being combined and designated the engineering department under the direction of a chief engineer. In recent years the railroad company had no single engineering head with the title of chief engineer.

In the reorganization, W. J. Backes, formerly engineer, maintenance-of-way, was appointed chief engineer; Frank C. Shepherd, formerly construction engineer, was appointed consulting engineer. He will be in charge of all engineering matters involving contact with public authorities, major construction work, and valuation. William F. Cummings, formerly valuation engineer and auditor of disbursements, was appointed engineer maintenance-of-way, with charge of the maintenance of electric wiring and signals as well as track and structures. Charles J. Griffin, formerly real estate engineer, has been appointed principal assistant engineer, Warren Y. Scott signal engineer, and John J. Kiley, office assistant. The engineer of structures and the office engineer under the new organization report to the principal assistant engineer. The positions of electrical engineer, architect, and real estate engineer are abolished, the duties being assumed by the principal engineer.

Experience Records

William J. Backes, chief engineer, is a native of Hartford, Conn., and a graduate of Sheffield Scientific School, Yale University, the class of 1899. He began his railroad work as a leveler on location with the Mexican International R.R. in 1899. From 1901 until 1903 he was in the engineering corps of the Pennsylvania R.R., then for two years he was a transitman on the New Haven, and in April, 1905, took charge of the engineering forces of the Bergen Hills section of the Pennsylvania tunnels into New York City. In May, 1906, he was appointed chief engineer of the Central New England R.R. which position he held until in May, 1913, he was appointed engineer, maintenance-of-way, of the New York, New Haven & Hartford R.R. Ten years later Mr. Backes was appointed assistant general manager of the same railroad in charge of maintenance, electrical, telegraph and signal departments, a position which he held until June, 1925.

Frank C. Shepherd, consulting engineer, is a native of Gloucester, Mass., and a graduate of Massachusetts Institute of Technology in the class of 1892. From 1892 to 1895 Mr. Shepherd was a transitman with the Metropolitan Sewage Commission of Massachusetts, then for two years he was assistant engineer with the Boston Transit Commission, and for a year in the Department of Yards and Docks of the Portsmouth Navy Yard. Subsequently, for two years he was in the employ of the city of Boston in its street departments. In 1902, Mr. Shepherd became resident engineer on the Grand Central Terminal improvements at New York, a position which he held until in 1906 he became construction superintendent for the O'Rourke Engineering Construction Co. at New York. The following year he was general superintendent for the Canadian-White Co. at Cedars, Quebec, and from 1908 until 1910 construction superintendent of the J. G. White Co. at Jackson, Ga. In 1911 he served as general superintendent for the James C. Stewart Co. at Brewerton, N. Y. Mr. Shepherd entered the service of the Boston & Maine in 1912 as engineer of construction. Subsequently he has served as valuation engineer, principal assistant engineer, assistant chief engineer, and chief construction engineer.

William F. Cummings was born at Charlestown, Mass., in December, 1887. He was a graduate of the Polytechnic School of the Boston Y.M.C.A. and of Lowell Institute, Boston. His service with the Boston & Maine R.R. has been continuous since 1906. In 1914, he was appointed an assistant engineer in the valuation department and has served in that department ever since, becoming valuation engineer in 1921.

Charles J. Griffin, was born at Everett, Mass., in 1882 and graduated from the Massachusetts Institute of Technology in 1904. Since that date, except for a few months' service with the New Haven, his service has been with the Boston & Maine Railroad Co., first as inspector, then as assistant engineer, resident engineer, division engineer of construction, and assistant engineer of valuation.

Mexican Boundary Water Negotiations Delayed

No early meeting of the International Water Commission, of which Dr. Elwood Mead is chairman, is contemplated. General Lansing H. Beach, one of the members of the commission, is in Europe and more data must be collected before the commission can discuss pending questions satisfactorily with the Mexican commission. The Air Service of the U. S. Army is making aerial maps of the Rio Grande and Tia Juana rivers, the route of the proposed All-American Canal and of Black and Boulder canyons. The Mexican government is paying half of the expense of the mapping of the border areas.

The Mexican commission has announced its willingness to meet the American commission at any time to begin the joint discussion of the problems to be solved. The statement has been made that the land owners in Mexico along the present canal are willing to revise the agreement governing the use of water diverted from the Colorado, but it is understood that the American commission believes that authority to build the All-American Canal should be a part of any Colorado River development bill, so that water supply to the Imperial Valley will be safeguarded.

Columbia River Bridge Project at Longview Approved

Findings have been reported by the Secretaries of War, Commerce and Agriculture, acting jointly, on the necessity for and adequacy of a proposed bridge between Longview, Wash., and Rainier, Ore. Construction of this bridge was authorized by Congress last January subject to approval by the three secretaries acting jointly, this being the first time that questions relating to a bridge over navigable waters have been dealt with for the federal government by any other authority than the War Department.

It is found by the secretaries that public convenience will be served to a limited extent by the proposed bridge, that the plans are in general adequate, and that the location selected is feasible for the erection of a suitable bridge. They find also that if suitable clearances are provided a bridge would not offer unreasonable obstruction to navigation, but they do not approve of the height and width clearances provided in the plans presented to them. Instead, they indicate that a main channel of 1,000 ft. width with vertical clearance of 175 ft. above low water should be provided, with center 1,400 ft. from the pierhead line on the Washington side; and that on the Longview side a 550-ft. channel with minimum clearance of 155 ft. should be provided. The commission indicates that it will approve plans meeting these requirements.

New York Port Authority Will Study Suburban Transit

The Port of New York Authority has announced that it will form a suburban transit board upon which there will be representatives of local transit agencies in the metropolitan district. It has called a meeting to discuss the subject on June 30. This action is the result of a request that the Port Authority take up the subject of suburban transit made by the New Jersey Legislature in which the North Jersey Transit Commission and the Westchester County Transit Commission joined.

The Port Authority believes that the proposed suburban transit board will be able to co-ordinate the activities of the various local transit bodies and prepare a comprehensive plan for financing them and putting them into execution. On this subject the Port Authority says: "If we can work out a successful plan with the railroads and others interested, it may be that the Port Authority can finance it. If the railroads come in and we are assured of a proper return, then there should be no difficulty in procuring the necessary funds. We had a conference with the railroad executives a few weeks ago and they expressed much interest in the problem. They are anxious to have something done and they said they would work with us for that purpose."

As the city of New York is anxious to maintain complete control over its subway system, the Port Authority anticipates that any suburban transit system which will be built will be independent of the city subway system.

New Refuse Collection Plan Voted for San Francisco

At the municipal election in San Francisco on June 14 an initiative measure amending the refuse collection and disposal ordinance was passed by a vote of 37,348 for, and 32,872 against out of a total registration of 235,000. The measure was brought up by the City Garbage Removal Co. which obtained the necessary signatures to place the proposition on the ballot. This company has been in controversy with the board of health over applications which the board denied, for collecting refuse in certain districts of the city.

The amendment makes it mandatory on the board of health to grant a permit for refuse collection whenever an applicant has secured signatures of 20 per cent of the patrons on any route to a statement that the service from the present scavenger is inadequate. The routes are designated on a map which divides the city into 97 zones. More than one applicant may secure a permit to collect on the same route. Maximum monthly rates are reduced from 5 to 10c. for collection from residences and flats and from 10c. to $2 for apartment houses. Provision that refuse of commercial value may be disposed of other than by delivery to the incinerator is omitted, as is the paragraph giving the board of health control over the design of vehicles that may be operated by scavengers. This revision of the ordinance is in effect the same as a charter amendment in that it can be strengthened, modified or repealed only by reference to, and vote of, the people.

Under the garbage collection ordinance that has been in effect in San Francisco since 1921 the board of health had power to control the routes covered by the scavengers, to investigate and remedy complaints, to compel the scavengers to maintain sanitary conditions and, by the establishment of maximum rates, to prevent overcharging. It has been the policy of the board that the garbage collection system could best be operated as a monopoly, and it was in opposition to this view that the amendment was proposed.

New Drainage Association Asks Flood Relief

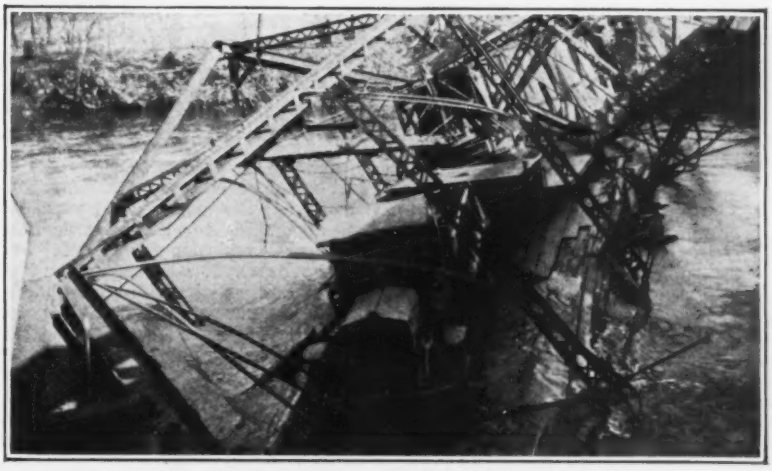
The National Drainage Association, with office at Memphis, Tenn., has been organized to represent a large group of drainage districts of the Mississippi Valley for the purpose of securing federal and state legislation giving tax relief for such districts. It is urged that the federal government assist the financing of land reclamation by drainage in the same way as reclamation by irrigation. Tax relief is needed by drainage districts which have suffered from the recent floods and have no means or resources for making repairs or improvements. About 70 drainage districts now members of the association represent an area of 3,650,000 acres and bond issues aggregating $37,365,000. The officers of the association include: President, W. H. Dick, Memphis, Tenn.; vice-president, James A. Finch, Missouri, and R. E. L. Wilson, Wilson, Arkansas.

Power Shovel on Heavy Truck Causes Bridge Failure

A steel truss bridge across the Little Schuylkill River at Molino, Pa., on the main highway from Port Clinton to Pottsville and about four miles from Port Clinton collapsed recently from overloading. Two large trucks pulling a trailer upon which was a power shovel, had started across the bridge. The first truck was across and the shovel was near the center of the span when the steelwork collapsed. As the shovel and truck fell into the water with the steel wreckage, the first truck was dragged back over the edge of the bank.

Adjoining the steel truss bridge is a recently completed reinforced-concrete arch bridge. The approaches to the new bridge were not completed nor was the driveway on the bridge when the accident occurred and traffic therefore had not been diverted from the old bridge.

The information contained herein was supplied by H. W. Savidge of Germantown, Pa.



COLLAPSED BRIDGE OVER SCHUYLKILL RIVER

Washington Notes

THE Alabama Power Co. has renewed its application for a license covering its proposed development at Lock 17 on the Warrior River near Attalla, Ala. A similar application, filed in 1923, was rejected by the commission when the then Chief of Engineers reported that the project would prevent the full development of the resources of the river. Further information intended to show that the conclusion of the engineers is not justified has been submitted with this application. The primary power that can be developed is 1,850 hp., but it is planned to install 28,000 hp.

UP TO June 1 the Federal Power Commission had issued during the fiscal year 51 licenses covering projects with a combined primary power capacity of 120,000 hp. at which 300,000 hp. will be installed. Eighteen preliminary permits have been issued. They cover 340,000 hp. of primary and 570,000 hp. of installed capacity.

BELIEVING that the limit has been reached in the financial burdens which can be laid on reclamation, officials in charge of this federal activity are more determined than ever that relief must come to insolvent projects through other means than the government taking them over and paying their debts. Moreover, the income of reclamation for the next ten years will be needed to complete the construction of projects already approved. If new financial burdens are imposed it would mean long delay in the completion of works, loss of money to the government and distress to settlers on existing projects. In fact, the existing policy all but is to adhere to the ten-year program and oppose any additions to that program until it is completed, or until economic conditions on existing projects are more satisfactory.

It is not believed that extensions of the time of payment, alone, will be of much assistance. Other steps essential to financial solvency must be added. Until the state, the county, the district and the local financial interests realize the importance of meeting obligations to the government, under contracts made, and join in a concerted effort to bring about the rapid settlement of the unimproved land by competent farmers, and until some agency has authority to bring about co-ordinated action in this land settlement and in the working out of a crop program so that earning power will be increased materially, it is Commissioner Mead's conviction that the government ought not to be asked to assume the economic and financial burdens of distressed private projects. Everywhere on federal and private projects it is felt that there must be better terms for settlement and better conditions for settlers and better machinery to select the right type of settler. The value of lands must be fixed by an impartial appraisal. Dr. Mead concedes that there must be a longer time in which to pay for them and that interest rates must be low.

Detroit Societies Defer Action On International Bridge

At a meeting held last week the Associated Technical Societies of Detroit decided to take no present action on a proposed resolution of endorsement of the Detroit River bridge. The society decided to defer action until a detailed study of plans and specifications may be made. The meeting took the form of an open discussion of the merits and objections to the proposed structure upon which the people of Detroit will vote June 28.

Speakers included J. W. Austin, treasurer of the American Transit Co., which with the Canadian Transit Co., proposes to build the bridge; Francis C. McMath, Detroit engineer and director of the Canadian Bridge Co.; Major John P. Hallihan, consulting engineer for the Detroit Rapid Transit Commission; Jonathan Jones, assistant chief engineer of the McClintic-Marshall Co. and Lester P. Barlow, representing the Union Highways Association of New York. Mr. McMath opposed the financing plan proposed whereby but $12,000,000 would be actually invested in bridge construction out of the first mortgage debenture and stock issue of $22,000,000. Mr. McMath was of the opinion that there reposed in the financing plan a good argument for public ownership of such a structure.

Brief News

Among the Gifts to Princeton University during the past year announced by President Hibben on June 19 were the following for the Engineering School: The executive committee of the Princeton Engineering Association, $25,000; James H. McGraw, president, McGraw-Hill Publishing Co., Inc., $5,000; James H. McGraw, Jr., $5,000; Curtis W. McGraw, $5,000. L. D. Ricketts gave $18,000 for the engineering school endowment.

To Study the Subject of Sewage Disposal and treatment in the metropolitan district, the mayor of Minneapolis has appointed to the Metropolitan Drainage Commission for St. Paul and Minneapolis C. F. Keyes, president of the Board of Estimate and Taxation, and the mayor of St. Paul has appointed Oscar Claussen, consulting engineer, formerly city engineer. The St. Paul City Council has appointed George M. Shepard, chief engineer of the Department of Public Works, and Governor Clarence Terse, a business man of Winona, Minn.

On June 16 the Public Building Commission adopted a building program for all federal buildings to be erected in Washington south of Pennsylvania Ave. to the Mall, in the triangle from Fifteenth St. to Tenth St., which will cost probably $175,000,000 spread over a long period. The contemplated program is to afford relief for federal offices now occupied under lease in temporary quarters, or where greater housing facilities are needed.

Random Lines

The Mississippi Flood

BY ELLDEE

The question is, what can be done,
At least expense of brawn and mon,
To harness Mississippi's flow
So there won't be no floods no mo'
Down where the cotton blossoms shoot
And Uncle Rastus toots his flute,
While Tebo, Romulus and Joe
Sweat in the patch with rake or hoe.

While many "cures" have been advanced,
None, so far, may be safely chanced,
For reasons anyone can see
Without an engineer's degree;
As, for example one wherein
It is suggested 3-Star gin
Be substituted for flood flow—
That great excess of H_2O.

The advocate of this wild dream
Believes that folks along the stream
Would break their necks to reach its banks,
Flop down and guzzle full their tanks
If the aforesaid tasty drink
Should fill the river to its brink!—
And thereby drain the stream bone dry;
A plan which almost makes one cry!

We've made a study of this thing,
A sketch of which we'd like to spring
By your kind leave, 'ere with a sigh
You lay your old *News-Record* by.
For we're convinced the plan we'd use—
And it has naught to do with booze—
Is, by a long shot, best as yet;
And will keep all from getting wet.

The Panama Canal, enlarged,
(Bills for the same could just be charged),
Dug deeper—14 miles let's say—
And then a gate at Limon Bay
Kept closed except when Missus Sip
Got on the rampage or the rip,
Then opened wide with adz or winch—
Would stop all flooding, it's a cinch.

The Gulf of Mexico's wide waste
Would then flow southward in great haste,
Rush through the gate in the canal,
Pass swiftly Moscow and La Salle
And in the broad Pacific's breast
Drain out and gently sink to rest,
Thus leaving one great, gaping hole
To serve as the flood water's goal!

An empty Gulf of Mexico
Would take care of all excess flow.
The Mississippi, dropping down,
Would spare plantation, pig and town;
Velocity would be so great
That floods would skate through every state
With never time to jump a bank,
And cause destruction, dire and dank!

* * *

Two More

(231) *Floor Covering Engineers*—M. Neuss & Sons, of Newark, N. J., who will put down your rugs, linoleum, etc.

(232) *Checkwriter Engineers*—Those who have perfected the Riteace Checkwriters, according to their advertisements.

Personal Notes

WILLIAM A. McCALLA and ROBERT L. KENAN announce the formation of a partnership with offices at 308-9 Bell Building, Montgomery, Ala., for the practice of civil engineering, with municipal and county work a specialty. Mr. McCalla was recently state highway engineer of Alabama. Mr. Kenan, also a civil engineer, was recently head of the firm, R. L. Kenan & Co., contractors, Selma, Ala.

A. F. SCHRAMM, who has recently completed the construction of the Bluewater Toltec Irrigation District at Bluewater, New Mexico, has returned to Wyoming, Ohio, for research work. Mr. Schramm has been identified with the development work of the southwest for the past 17 years in irrigation and drainage works and will soon return to Roswell, N. M., for the development of lands in that vicinity.

JAMES D. KENT, who has been employed in street railway work in New York City and environs since May, 1894, leaves street railway work to enter construction field and will form a new department to be known as the track division with the Arthur A. Johnson Corporation, general contractors, 3rd & West Streets, Long Island City. He joined the old Metropolitan Street Railway Co. at the time John D. Crimmins was president and aside from military experience of twenty months when he was engineer depot officer at Philadelphia and later assistant port storage officer at Newport News, he has been almost continuously employed on street railways.

ALEXANDER FERGUSON of the Department of Railways and Canals, Ottawa, has been appointed general assistant engineer of the Montreal Harbor Commission.

WILLIAM E. WICKENDEN, New York City, director of research for the Society for the Promotion of Engineering Education, was given the degree of doctor of engineering by Worcester Polytechnic Institute June 20. Mr. Wickenden also delivered the principal address at the institute's commencement.

H. D. TUBBS has been appointed resident engineer in charge of the new McGrew yard and grade revision of the Pere Marquette Ry. at Flint, Mich.

FRANK MANNING has been promoted to assistant division engineer of the Pere Marquette Ry. at Grand Rapids, Mich.

RALPH W. POWELL, associate professor of applied mathematics at the College of Yale in China, Changsha, China, following the evacuation of Americans from Hunan Province has returned to America and has taken a temporary position in the U. S. Engineer office at Chattanooga, Tenn. Mr. Powell went to China in 1916 after several years of teaching mechanics and civil engineering at Michigan State College, Cornell and Yale.

RALPH ADAMS, Arlington, Mass., has resigned as junior engineer with the New York Central R. R., to become associated with Henry S. Adams, consulting engineer, Boston, Mass. During the past year he worked for the New York Central on the third-tracking of the West Shore R. R. between Voorheesville and South Schenectady, N. Y. Mr. Adams is a graduate of Dartmouth and studied engineering at Massachusetts Institute of Technology.

CLARK D. PARSONS, formerly with the Department of Public Works of Buffalo, N. Y., recently completed his work as engineer in charge of the design and construction of the new filtration plant at Buffalo, and has opened an engineering office in Orlando, Fla., for general engineering business including design and supervision of construction, surveys, plans and estimates. Mr. Parsons has during recent years been identified with the U. S. Engineers, the New York State Highway Department, and the Buffalo filtration project.

F. S. HEWES, division engineer of the Atchison Topeka & Santa Fé Ry., at Slaton, Tex., has been appointed office engineer at Chicago, succeeding J. DE N. MACOMB, resigned.

J. ANDREUCETTI, assistant electrical engineer of the Chicago & Northwestern Ry., has been appointed electrical engineer, to succeed A. J. Farrelly, retired.

J. WALTER ATLEE, Baltimore, Md., is now located on the Conowingo, Md., power project with the field engineering force of Stone & Webster. Mr. AtLee was formerly engineer-inspector for the Southern Ry. at Atlanta, Ga., and Asheville, N. C. He was assistant engineer of mines for the C. H. Mead interests, in West Virginia in 1912 and 1922.

ROBERT J. HARDING sailed June 4 for Bahia, Brazil, to examine and report upon water-works and sewerage for Hazen & Whipple, New York City.

GUY L. BAYLEY has been appointed by Sanderson & Porter, Engineers, Chicago, New York and San Francisco, manager of the Chicago office at 231 S. LaSalle St., succeeding CECIL F. ELMES.

F. E. BUCK, of the University of British Columbia, at Vancouver, has been elected president of the Town Planning Institute of Canada for the ensuing year. The three vice-presidents elected were: MAJOR D. H. MELLS, Ottawa; P. E. NOBBS, Montreal, and A. G. DALZELL, Toronto.

CLYDE E. BECKETT and GEORGE S. HOLLAND have been added to the engineering staff of the concrete department of the Celite Products Co. at its Chicago office. Mr. Beckett was formerly with the L. E. Myers Co., of Chicago, and Mr. Holland was formerly in the engineering department of the city of Des Moines, Iowa, and later with the Harrison Construction Co. at Des Moines.

HUGH W. CRAWFORD, recently of Kansas City, Mo., has been appointed city engineer of Ponca City, Okla., succeeding E. A. JONES, who has held the position for the past four years and who will locate at Enid, Okla., as a consulting engineer. From 1920 to 1924 Mr. Crawford was city engineer of Independence, Kan., and since 1924 has been a member of a consulting engineering firm at Kansas City. Formerly he was for eight years with the engineering corps of the United States Army.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, French Lick, Ind., June 20-24, 1927.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, New York City; Annual Meeting, Orono, Maine, June 27-30, 1927.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Summer Meeting, Denver, Colo., July 13-16, 1927.

The Association of City Engineers of the State of New York at its recent meeting at Niagara Falls elected as president Harry Hayes, city engineer, Utica; as vice-president, Nelson F. Pitts, city engineer of Syracuse; and as secretary-treasurer, Edward Prentice, of Binghamton. The association effected its organization at this meeting at Niagara Falls. Mr. Pitts was one of the principal speakers, discussing the difficulties of city engineers in carrying out municipal improvement programs, and showing with moving pictures the gradual conversion of abandoned parts of the Erie Canal into a highway.

Obituary

HERMAN R. HOLLJES, 36 years old, an engineer in the test department of the Baltimore & Ohio R.R. Co., Baltimore, died on Monday, June 13. During the war Mr. Holljes served as a first lieutenant in the Fifth Regiment of Marines.

DR. H. P. TALBOT, dean of Massachusetts Institute of Technology since 1921, died June 18 at a Boston hospital after an operation. Dean Talbot was born in Boston in 1864 and graduated from the Massachusetts Institute of Technology in 1885, since which time he had been on the faculty. He received a Ph.D. degree from Leipzig University in 1890. At the Institute, he was instructor, assistant professor and associate professor. From 1895 he held the position of professor of analytical chemistry and from 1898 that of professor of inorganic and analytical chemistry. He was long connected with the work of the American Chemical Society and of the Society for the Promotion of Engineering Education. During the war he served the U. S. Bureau of Mines in chemical research. He was the author of noted works on chemical matters.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer is Doing for the Engineer and Contractor

First of Series of Distribution Statistics Available

Some months ago, Mr. Herbert Hoover, Secretary of Commerce of the United States, authorized the Bureau of the Census to proceed with a limited census of distribution as a sort of test to determine its possibilities. Consequently, the census is being carried on in 11 cities: Atlanta, Baltimore, Chicago, Denver, Fargo, Kansas City, Providence, San Francisco, Seattle, Springfield (Ill.) and Syracuse. The report on the Baltimore census, which is the first to be made available, reveals and suggests many possibilities for a nation-wide census of distribution. Although there are countless series of production statistics available, these are the first distribution figures to be placed on an official basis.

The census mainly considered those establishments engaged primarily in the distribution of commodities. A few of the important figures disclosed by this Baltimore census included the fact that during 1926 each retail establishment averaged $31,617 in sales, or $454.82 per capita; salaries and wages represented about 12 per cent of sales; the annual average amount of sales per employee amounted to $7,581; and that there was one retail store for every 70 inhabitants in Baltimore at the close of 1926. For wholesale establishments the average sales were $295,292 and salaries and wages amounted to about 6 per cent of sales.

Many detailed classifications which are likely to be most useful in applying the results of this research to individual businesses are now being made by the Bureau of the Census and will be available within a few months.

Cleveland Is Building for Next Year's Road Show

Work is progressing rapidly on the $2,000,000 addition to the Cleveland Public Auditorium where the convention and road show of the American Road Builders Association will be held next January. The size of the present structure is 200x500 ft. The addition will make the hall one block long, providing 45 per cent more exhibition space than was available in Chicago. The illustration shows a one-yard Osgood gas shovel working in the new excavation. The general contract was let to the Hunkin-Conkey Construction Co. The excavation, which involves about 47,000 cu.yd., was sublet to Frank J. Smith.

Business Notes

SEIBERT-MCNEILLY MACHINERY CO., Columbus, Ohio., has been recently formed as distributor for a number of well-known construction equipment manufacturers. The partnership is formed by Myron S. Seibert, formerly of Seibert-Milburn Co., and John McNeilly, who has for several years been in the construction machinery business in Columbus.

YEOMANS BROTHERS CO., Chicago, has appointed three new distributors: Houston, Tex., Texas Engineering Co.; Dallas, Tex., Dillard Engineering Co., and Grand Rapids, Mich., Heating & Ventilating Equipment Co.

CONSTRUCTION MACHINERY CO., Waterloo, Iowa, announces that Paul Johnson has recently been appointed sales manager. Mr. Johnson was formerly connected with the Humphreys Mfg. Co.

LINCOLN ELECTRIC CO., Cleveland, Ohio, announces the appointment of Royal D. Malm as western district sales manager, with headquarters at Chicago.

THE CHICAGO PNEUMATIC TOOL CO., New York City, announces the closing of its two offices in Dallas and Houston, Texas, incident to the appointment of Whealton & Townsend, Inc., with main offices at 120 East Brady St., Tulsa, Oklahoma, as distributors of Chicago pneumatic products in the state of Texas east of Meridian 102. Whealton & Townsend, Inc., will maintain sales and service offices in both Dallas and Houston, and will establish additional offices elsewhere when conditions of business warrant.

J. GUY HALL, formerly chief engineer for H. Miscampbell, Duluth, Minn., is president and general manager of a new organization, Limestone Products, Inc., at Ocala, Florida, which will produce soft road rock, concrete aggregates, lump lime and hydrated lime.

THOMAS H. COMFORT, who was until recently employed by the McClintic Marshall Co. in Chicago in checking structural details has entered employment with the St. Paul Structural Steel Co., St. Paul, Minn., as an engineer, working on design, estimating and sales.

FALK CORP., Milwaukee, manufacturers of herringbone gears, speed reducers, steel castings, Diesel engines and flexible couplings, has opened an office at 122 South Michigan Ave., Chicago, the office to be in charge of C. H. Thomas.

JOSEPH L. PIERCE, assistant secretary the National Water Main Cleaning Co., New York, died suddenly May 31. Mr. Pierce had been with the National Water Main Cleaning Co. for 19 years. He was also an active worker in the New York section of the American Water Works Association. Mr. Pierce was 40 years old.

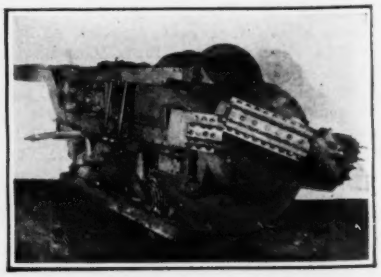
New Developments

Portable Hand-Saw Operated by Compressed Air

An automatic portable hand-saw operated by compressed air, claimed to do five times the work of an ordinary saw, has been developed by the Ingersoll-Rand Co., 11 Broadway, New York City. By shifting blades, the saw will cut materials such as wood, soapstone, wallboard, cables, copper etc. Cross-cut or rip blades are available. The 8-inch hand-saw weighs 23 pounds. The design uses a three-cylinder type air motor and a safety saw guard. The latter is of a telescopic nature, opening when the saw is applied to the material and automatically closing and locking in position as the cut is completed. An adjustable stop permits the saw to be set for a required depth of cut. Three sizes of saws are available with 6, 8 and 12 inch blades.

Electric Tunnelling Machine

A new tunnelling machine has recently been developed by the Pioneer Machine & Engineering Co., Cleveland, for boring tunnels from 5 to 8 ft.



in diameter through such materials as shale, limestone and sandstone. It is claimed that a recent test on a Cleveland job proved that the machine cannot be stalled when cutting through the above substances at the rate of 5 ft. an hour. The machine is electrically driven by a 75-hp. motor. All castings are of open-hearth steel and the cutting teeth are of tool steel.

In operation, the revolving cutting teeth chip the rock and dirt, throwing it into buckets, shown in the illustration at the head of the machine. From these buckets the soil is emptied onto a conveyor carrying through the machine to the back and discharging into dump cars. There are two cutting heads operating in opposite directions. The machine is anchored by hydraulic jacks on either side of the machine, bearing against the side of the tunnel walls; the machine is also crowded by means of hydraulic jacks. The total weight of the tunnelling machine is 12 tons.

New Fordson Clam Shell Crane

A Fordson crane for clam shell work has recently been developed by the Wilford Universal Power Shovel Co., Detroit. It operates on a ¾ circle swing

and various boom lengths are available up to 24 feet. The clam is of ¼ yard capacity.

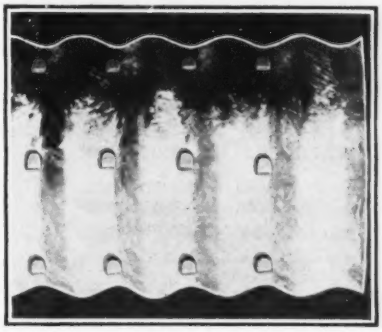
Electric Locomotive Operates from Trolley or Battery

The Chicago, North Shore & Milwaukee Railroad Co. has obtained two 65-ton electric locomotives which will operate either from a trolley or from storage batteries. While operating from the trolley the locomotive charges its battery through a motor generator set. It is claimed that these locomotives are the first of this type and that one of their main advantages is that they can switch cars into industrial plants equipped with tracks but not trolley connections.

Four 200-hp. motors and a storage battery of 192 cells delivering 260 kw. on one charge are provided. Operating on the battery, the locomotive can haul 33 loaded freight cars 5¼ miles at 12 m.p.h. on one charge. Maximum speed light is 37 m.p.h. The locomotives are being built by the General Electric Co. and will be equipped with storage batteries furnished by the Electric Storage Battery Co.

Improved Type of Perforated Culvert Pipe

A new type perforated culvert pipe of corrugated galvanized iron has recently been announced by the Canton



Culvert & Silo Co., Canton, Ohio, in which the perforations are punched in the upper two-thirds of the circumference and each hole protected by an outward-pressed tongue raised about ¼ in. from the body of the pipe. This construction is claimed to greatly retard the entry of silt and dirt into the pipe, and at the same time permit excess water to be carried off quickly and completely. The base metal used is 16 gage or heavier Toncan copper molybdenum iron which consists of .4 per cent copper and .05 per cent molybdenum and forms an alloy which is said to have many times the rust and corrosion resistance of ordinary iron. Tees, ells and curved sections to any radius can be supplied, as well as flat bottom pipe for use where head room is limited. Nestable types, permitting compact shipment and easy field assembly, are manufactured in addition to full circle riveted construction.

A New Steel Pipe

A new steel pipe, for which a number of advantages are claimed, has recently been developed by the A. O. Smith Corporation, Milwaukee, primarily for use in the oil fields but adaptable for construction and industrial uses. It is known as Smithsteel gas line pipe and a new mill has been erected by the company to manufacture it by what is claimed to be a new process. The mill will have a capacity of 4½ miles of pipe per day, in sizes of 16 to 22 in. diameter and in uniform lengths of from 10 to 30 ft.

It is claimed that the new process makes the production of pipe of uniform wall thickness, diameters and lengths virtually automatic. Accuracy in diameter and in thickness is especially advantageous in producing efficient welded joints. The pipe is offered in both plain end and plain end beveled for field couplings or for welding. Another feature about the pipe is that thickness can be specified by the purchaser for each individual job. Since the manufacturing method is claimed to produce pipe of practically any thickness design specifications may be made much closer to actual requirements.

Manufacturers and Trade Associations

Calendar

Annual Meetings

NATIONAL HARDWOOD LUMBER ASSOCIATION, Chicago; Annual Convention, Chicago, Sept. 15-16.

AMERICAN PAINT & VARNISH MANUFACTURERS ASSOCIATION, Philadelphia; Annual Convention, Atlantic City, Oct. 24-25.

NATIONAL ASSOCIATION OF MANUFACTURERS; Annual meeting, Chattanooga, Tenn., October 25, 26 and 27.

New Publications

Storage Tanks—GRAVER CORP., East Chicago, Ind., recently issued a 48-p. booklet containing chiefly illustrations of steel bulk storage tanks of various types. In addition, however, there are specifications and standard-size tables, and the booklet is completed by a number of pages devoted to drawings of bulk station layouts.

Tunnel Shovels—ST. LOUIS POWER SHOVEL CO., St. Louis, Mo., has issued an 8-p. folder describing the all steel Conway shovel and giving illustrations of its use on many of the large tunnels now under construction. Sketches of car switching facilities and other operating data are included. Necessary information for ordering is given as well as are drawings of machine details.

Concrete Mixers—KOEHRING COMPANY, Milwaukee, Wis., has issued a new paver catalog describing and illustrating its line of pavers, giving complete specifications for its 27-E, 13-E and 7-E mixers. Illustrations of the timing device, water measuring equipment, the frame and other construction and mechanical details are given.

Ditching Machines.—BARBER-GREENE CO., Aurora, Ill., has issued a 30-page catalog entitled "Ditching Snapshots and Records" in which a large number of illustrations are shown of the company's ditching machines in use on various types of work. The booklet shows in a striking way the applications for which the company's vertical boom ditcher is adaptable.

Business Side of Construction

Facts and Events That Affect Cost and Volume

This Week's Contracts—With Comparisons

Minimum costs observed are: $15,000 for water-works and excavation, drainage, irrigation, levee, river and harbor projects; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, institutional, religious and other buildings.

Week ended	Public Work	Private Work	Total Contracts
June 23, 1927	$38,636,000	$34,406,000	$73,042,000
June 16, 1927	17,537,000	31,635,000	49,172,000
June 24, 1926	19,894,000	23,717,000	43,611,000
Jan. 1 to date			
1927	579,161,000	860,269,000	1,439,430,000
1926	509,711,000	850,296,000	1,360,007,000

E.N.-R. Index Numbers On June 1, 1927

COST	VOLUME
205.55	*299*

The Index Numbers are published in detail and with charts in the first issue of each month. The Cost Index is given in full from 1903 through 1926, with a thorough explanation of its method of computation, and a graphic comparison with many other index numbers, in the 48-page pamphlet entitled Engineering News-Record Construction Costs.

Weekly Construction Market

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb	$3.34	$3.80	$4.00	$3.10	$3.35	$3.87½	$3.00	$3.00	$4.00
Structural rivets, 100 lb	5.00	3.80	4.75	3.50	3.75	4.65	5.00	5.00	—5.50
Reinforcing bars, ¾ in. up, 100 lb	3.24	2.80	2.75	2.30@2.50	2.87½	—3.77½	2.95	3.00	3.57
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	54%	51%	48%	41%	42@53.8%	48%	37.83
Cast-iron pipe, 6 in. and over, ton	47.60	40.75	54.00	44.20	—46.50	56.50	46.00	55.00	—55.00
Concreting Material									
Cement without bags, bbl.	2.35@2.50	2.40	2.05	2.05	2.22	2.85	2.51	2.65	+2.22
Gravel, ¾ in., cu.yd	1.75	2.20	2.38	1.70	1.65	1.90	1.80	1.25	1.90
Sand, cu.yd	1.00	1.40	2.00	1.65	1.25	1.00	1.40	1.25	1.35
Crushed stone, ¾ in., cu.yd	1.94	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	59@61	34.00	56.00	40.50	39.25	34.25	27.00	23.00	+55.00
Lime, finishing, hydrated, ton	18.20	24.50	19.00	20.00	25.50	24.00	27.50	24.00	21.00
Lime, common, lump, per bbl	2.10@3.00	—1.35	1.82	1.50	1.70	2.70	1.70	2.80	10.00
Common brick, delivered, 1,000	19@20	12.50	14.10	12.00	13.75	9@10	14.00	14.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0724	— 103	.076	.072	.085	.....	.10	.10
Hollow partition tile 4x12x12, per block	.1027	.0724	—.103	076	.072	.085	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	.89¼	—.93	1.10	90	—.97½	1.10	.95	95	—1.03
Common Labor									
Common labor, union, hour	.90½	.30	.. ..	.90	.....	.....	.60	.62½	.....
Common labor, non-union, hour	....	.25	30@.50	....	.45@.60	.31¼@.50	.50	.62½	.30@.35

THESE contract comparisons, shown in the table at the top of the page, indicate the direction of demand for construction materials and labor.

There being no well developed scarcity at present in any of the materials in common use, the continued high volume of awards means that if prices do tend downward, owing to heavy production, the descent must necessarily be very gradual.

The contract figures referred to are for the entire U. S. on large sized jobs. Conditions in a given locality, with relation to demand, might be different from those obtaining in the country as a whole, yet production of the major materials is so arranged that important price movements are generally nation-wide in effect.

Building materials as a group show greater firmness at present than for the corresponding period in either of the last two years, marking the first upturn since November, 1926. Wholesale commodities moved similarly.

THIS limited price list is published weekly except in the first issue of each month and gives current prices on the principal construction materials in the chief cities. The first issue of each month carries complete quotations for all of the basic materials and for the rest of the important cities, also wage rates for the principal building trades and common labor. The last complete list will be found in the issue of June 2, the next on July 1. Valuable suggestions on costs of work can be had by noting actual biddings as reported in the Construction News and Unit Prices sections following. Explanation of prices contained in the table will appear from time to time in this section; last shown in issue of June 16, 1927, p. 1006.

PRICE OF STRUCTURAL RIVETS PER 100 LB.

City	One Month Ago	One Year Ago
New York	$5.00	$4.50
Atlanta	3.80	3.50
Dallas	4.75	4.75
Chicago	3.50	3.50
Minneapolis	3.75	3.75
Denver	4.65	4.65
San Francisco	5.00	5.00
Seattle	5.00	4.00
Montreal	7.00	5.50

Hardwood lumber prices are sufficiently firm to offset any weakness that may be present in the pine and fir markets. Latest reports indicate that considerable time must elapse before effects of the Mississippi floods are completely eradicated from the market in this material.

Prices of sand and gravel show the usual tendency toward local fluctuations, while a decidedly downward trend is evident in lime, tile, brick, roofing, and paint materials.

Red and white lead dropped ½c. per lb., f.o.b. New York, June 16, 1927, as compared with prices in effect Dec. 16, 1926.

Steel structurals remain at practically the same price levels occupied three months ago. The principal hot-rolled items sell at $1.90 per 100 lb., base, Pittsburgh mill, in ordinary tonnages. A minimum of $1.75 is reported on reinforcing bars and plates, with $1.70 for shapes, where exceptionally large orders are involved.

Building Trades Wage Trend Continues Upward

Movement Has Been In Opposite Direction From That of Materials Costs During Last Five Years

When the *Engineering News-Record* Construction Cost Index Number was first devised, in the early part of 1921, it was adjudged that the labor element should be 38 per cent of the Index in the base year (1913). This element had moved to 46 per cent in 1920, and to-day is 54 per cent.

Fig. 1 gives a reasonably accurate picture of the advance of building labor rates compared with the advance and their decline of building materials prices and living costs. Prices, it will be seen, had all the better of it during the war. Skilled labor began the real climb in 1918 and, except for a drop in 1922, has kept it up, according to figures of the United States Bureau of Labor Statistics. Common labor rose abruptly in 1919 and since 1921, except for a dip in 1925, has maintained a gentle rise. These figures, gathered by *Engineering News-Record*, cover the following seven cities: Boston, New York, Birmingham, Chicago, St. Louis, San Francisco and Seattle.

FIG.1
INDEX NUMBERS OF LABOR RATES
Compared with Building Materials and Living Cost—1913 (100) to 1926
Per Cent
1913 = 100
Skilled trades (U.S. Bureau Labor Statistics)
Common labor, six cities
Cost of living in December (U.S. Bur. Lab. Stat.)
Building materials
Engineering News-Record Chart
1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926

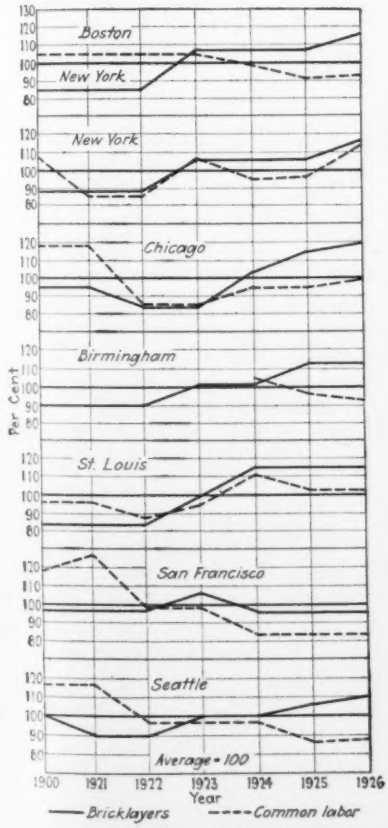


FIG. 2—WAGE TRENDS SINCE 1920 COMPARED WITH AVERAGE OF LAST SEVEN YEARS

Construction Cost Stabilization in South

Situation Reflected by Materials Prices and Building Trades Labor Rates in Birmingham and Atlanta

THE price stabilization that has been going on in the construction industry throughout the country in the last three years is evident also in the South, as reflected by materials prices in Birmingham and Atlanta. The charts show the trends from 1914 in Birmingham and from 1918 in Atlanta. Average yearly labor rates are plotted in Charts III and IV from 1914 to March, 1927. The cost movements are here given in detail.

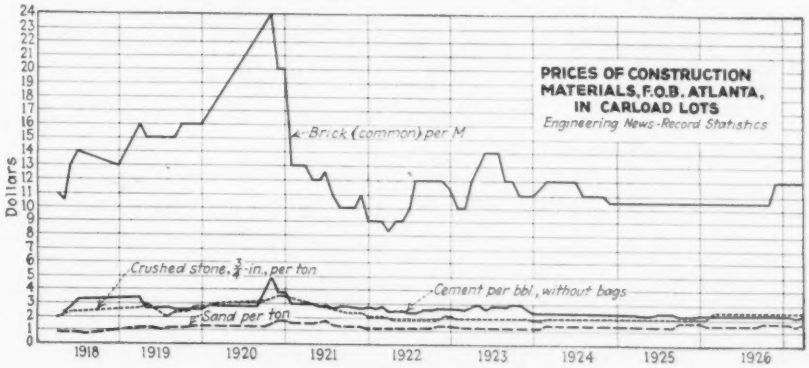
MATERIALS PRICES IN BIRMINGHAM

Reinforcing Bars—In May, 1914, reinforcing bars were quoted at $1 per 100 lb. and $2 in the same month of both 1916 and 1917. The next quotation is for May, 1921, and is $2.35. Thereafter, the peak was $2.75, and was reached in August, 1921, and in August and September, 1924. Since January, 1925, the price has been stable at $2.25.

Cast Iron Pipe—The 1914 average price of cast-iron pipe was $20 per ton. Heavy increases were registered in 1917—from $36 to $40, to $50, to $60, all within the year. The peak was $74, reached in the last two months of 1920. One year later the price was $32 per ton. The market was stabilized in 1925, and the present price is $38.

Lumber — In 1915 pine timbers (3x12 to 12x12, 20-ft. and under) could be bought for $15 per M. ft. b. m. The price is now stabilized at $34—unchanged since February, 1925.

(*Continued on p. 1044*)


PRICES OF CONSTRUCTION MATERIALS, F.O.B. ATLANTA, IN CARLOAD LOTS
Engineering News-Record Statistics
Dollars
Brick (common) per M
Crushed stone, ¾-in., per ton
Cement per bbl., without bags
Sand per ton
1918 1919 1920 1921 1922 1923 1924 1925 1926

Trend Away From Small Residential Construction

The rapid increase in apartment house living in American cities in recent years, is shown clearly by the building permit records compiled by the Bureau of Labor Statistics. These figures on new construction indicate that a change is taking place, although no details are available regarding the actual number of families now living in apartment houses as compared with those living in single dwellings.

In 1926 approximately half of the housekeeping dwellings provided by new construction were apartments. Cities of over 500,000 inhabitants, as a general rule, had a larger proportion of apartment structures, although during the last two years this has also been true of most of the suburbs of the larger cities.

This change in the character of American homes, the bureau claims, has a serious effect on wage earners of the country, since it means a decrease in home ownership and also adversely affects certain of the building trades mechanics employed in dwelling house construction.

Ordinarily, in the construction of single family dwellings, the bulk of the labor is represented by bricklayers and carpenters, the crafts most affected, while in large apartment houses, the services of structural iron and steel, concrete, stone, tile and sheet-metal workers are required.

The big, and what may be called the "legitimate boost," in labor rates took place in the three-year period, 1918-1920. The trends since then, though upward, have been far less sharp. It is these trends, however, that are particularly worth studying. The rise following the close of the war can be easily comprehended. It is the continual rise that calls for consideration. A good way to measure the trends of the last seven years is to plot them as a percentage of the average for these years. This is done in Fig. 2, in which 100 represents the average wage of skilled labor, here represented by the key trade (bricklayers), and the average wage of common labor.

The trends are plain: of the seven cities only in San Francisco are skilled labor wages below the seven-years average.

Construction Cost Stabilization in the South

(*Continued from p. 1043*)

Lime—There have been no exaggerated fluctuations in common lump lime. From $1 per 180 lb. bbl., the price rose to $1.85, which has been maintained since December, 1925. Hydrated lime moved from $14.25 per ton in 1923 to $22.50 in March, 1925, and that has been the price ever since.

Materials Prices in Atlanta

Cement—As in the cases of all other materials here considered, the price of cement has jogged along evenly in the last few years. It was highest in 1920, and since December, 1923, has remained at $2.35 except for an occasional rise or fall of 5 or 10 cents.

Crushed Stone—The range in the last ten years was from $1.88 per ton in March, 1918, to $3.50 in 1920. The current quotation is $2.50, which has held for the last year.

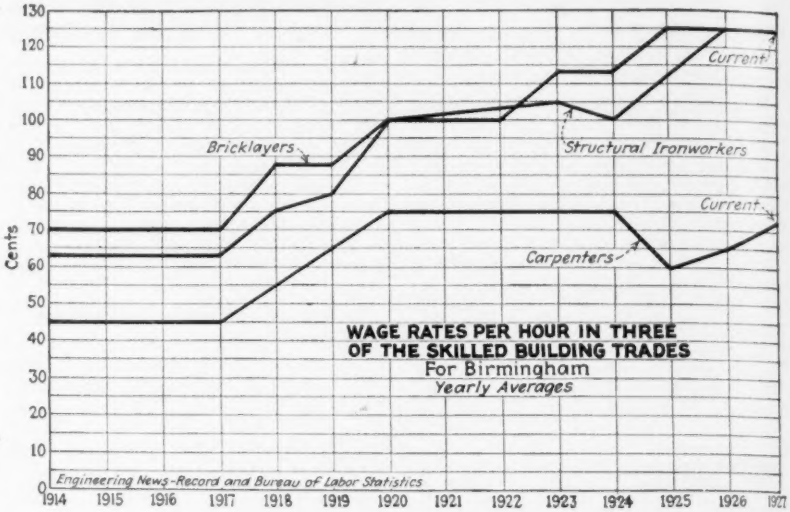
Sand—The range in the last two years has been $1.40-$1.65, with $1.60 the current quotation.

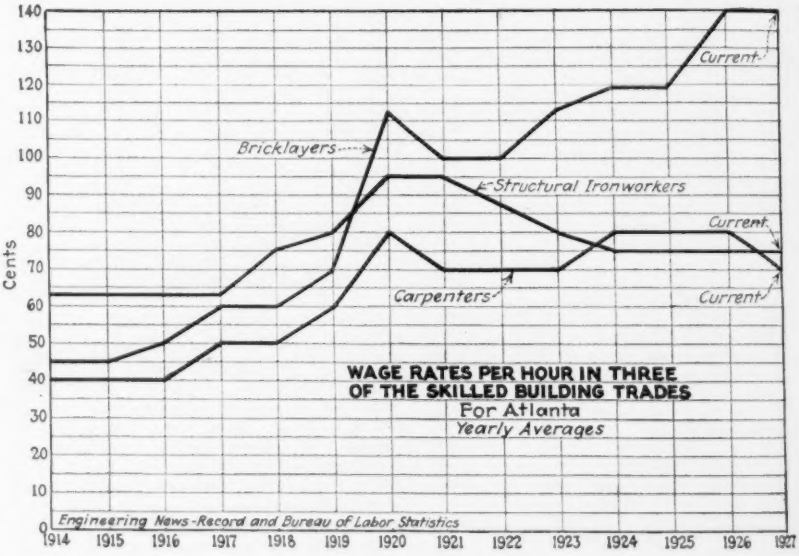
Brick—From $11 per M. in 1918, the price of common brick rose steadily to $24 in 1920. Deflation in 1921 brought the price to $9. A price of $10.50 was quoted from November, 1924, until October, 1926; since then $12.

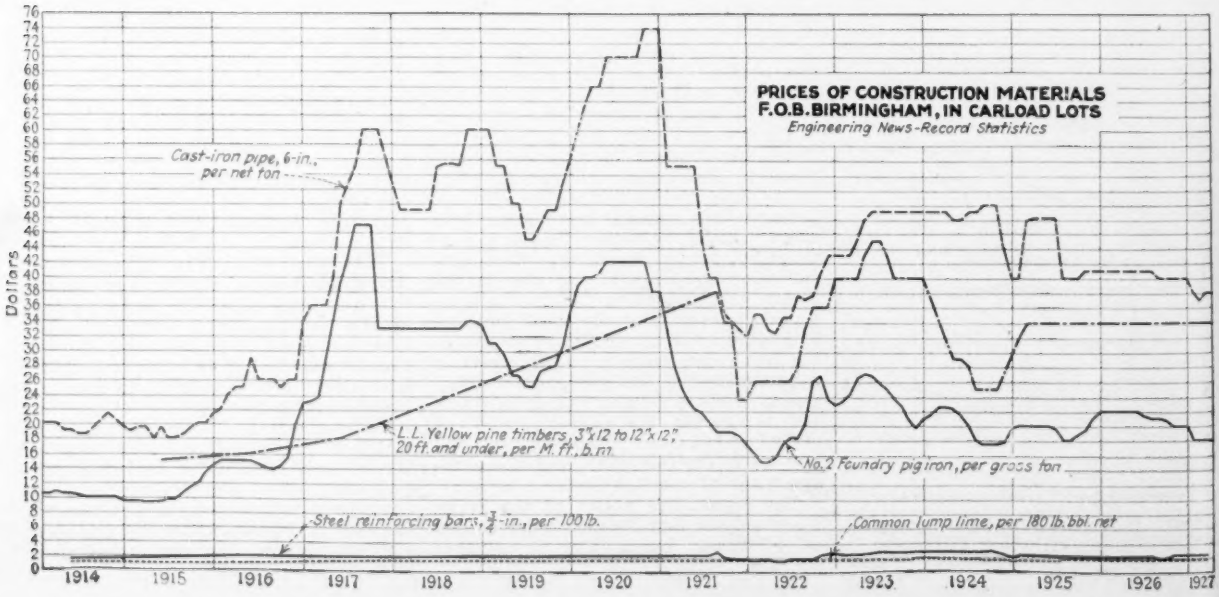
Labor Rates

Birmingham — Carpenters reached their maximum wage rate of 75 cents in 1920 and maintained it to the end of 1923. The low point since then was 62.5 cents. Current rate is 72.5 cents. Bricklayers and structural ironworkers both receive $1.25 per hour. In the period 1914-1917 the rates were as follows: carpenters, 45 cents; ironworkers, 62.5 cents; bricklayers, 70 cents.

Atlanta—Structural ironworkers received 62.5 cents per hour in 1914-1917 and have been paid 75 cents for the last four years. The peak in 1920-1921 was only 95 cents. Carpenters, at 40 cents, in 1914-1916, now receive 70 cents—10 cents less than in 1924-1926. The case of bricklayers is very different—from 45 cents in 1914-1915 to $1.40 since 1926.






Dollars
PRICES OF CONSTRUCTION MATERIALS
F.O.B. BIRMINGHAM, IN CARLOAD LOTS
Engineering News-Record Statistics
Cast-iron pipe, 6-in., per net ton
L. L. Yellow pine timbers, 3"x12 to 12"x12", 20 ft. and under, per M. ft., b.m.
No. 2 Foundry pig iron, per gross ton
Steel reinforcing bars, ¾-in., per 100 lb.
Common lump lime, per 180 lb. bbl. net
1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927

25

ce

1927

1927

1927